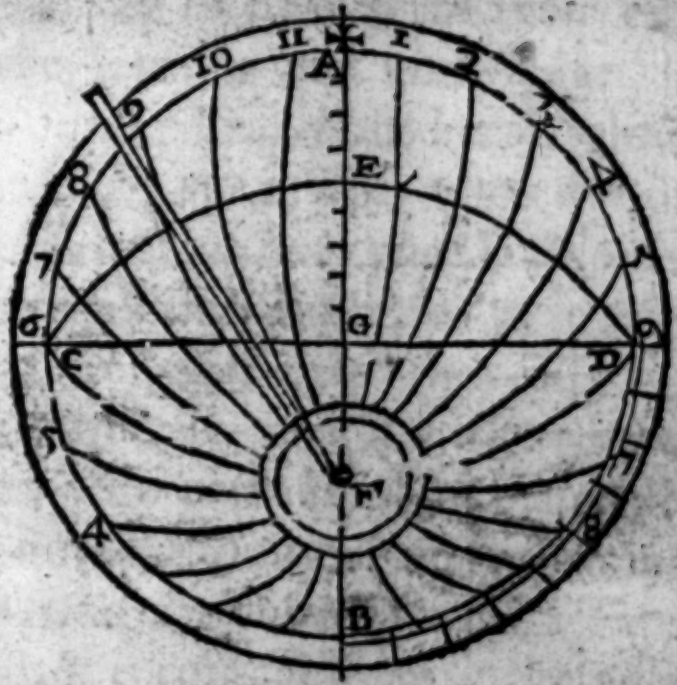
THE ART OF DYALLING IN TWO PARTS.

The first shewing plainly, and in a maner mechanichally to make dyals to all plaines, either Horizontall, Murall, declining, reclining or inclining, with the *theoricke of the Arte.*

The second how to performe the selfe same, in a more artificiall kinde, and without vse of Arithmeticke, together with concaue and conuex Dyals, and the inserting of the 12. signes, and the howres of any other country in any dyall, with many other things to the same Art appertaining.

The whole differing much from all that hath beene heretofore *written of the same Art by any other, and the greater part wrought by diuerse new conceits of the Author, neuer yet extant, now published.*

By IOHN BLAGRAVE of Reading Gentleman, and Mathematician this yeare, 1609.



AT LONDON,
Printed by *N. O.* for *Simon Waterson*, and are to be sold at his shop in Paules Church yard, at the signe of the Crowne, 1609.

TO THE RIGHT HONOVRABLE, SIR THOMAS PARRY Knight, Chauncellor of the Dutchy of Lancaſter, and one of his Highneſſe moſt honorable Priuy *Councell.*

IT is a great and moſt happie comfort (Right Honorable) to perſons of meane eſtate, and no ſmall bounty in great men, whom the high God of heauen for their exceeding vertue, learning and knowledge, hath exalted to be his Vicegerents heere below, or as a man may ſay, euen Gods vpon the earth, in reſpect of their authority and wiſdome, to guide, gouerne, and direct the rude vulgar ſorte. That yet ſuch men will not only looke aſide from their ſo weighty charge, and high places, vnto perſons of meane reſpect, that either liue vertuouſly, or apply their indeuours vnto good acts or ſciences, but alſo protect, defend, & encourage them in their good

courſes. Of this kind of happineſſe, I moſt humbly thanke the almighty, I haue hetherto neuer wanted, nether in courte nor country: But yet alas, time hath bereft me, many my moſt Honorable fauorours. And only your Honour now ſucceeding your Honorable Father in place of honour, is the principall hope left vnto me, who in my Mathematicke infantry, both fauoured me, & furniſhed me out of your admirable and generall library, of ſuch Mathematicke books, as in thoſe daies were hardly, or not elſe where to be gotten, and euery way els was moſt gratious towards mee, without any alteration, euen to the time that your Honor was called from vs to be Lord Embaſſador in France. And therfore I am the rather emboldened, not to wrong myſelfe ſo much as to ſuffer my ſelfe to be altogether forgotten of your honour, and to the end that your Honour, ſhould not doubt but that I remain alwais one & the ſame: I haue catch out of my Mathematicke ſtore-houſe, this rude booke of dyalling, becauſe of ſundry other that I haue in hand, it was neereſt at an end, in which I preſume, there is ſomewhat extraordinary, though the ſubiect be but ordinary, to witneſſe the continuance of my indeuours, which ſimple

worke

worke, if your Honour vouchsafe; of your wonted goodnesse, to grace and patronize, I shall thinke my wonted happinesse, still to haue continuance. Thus being loth to be ouer tedious, I most heartily pray to God for the long preseruation of your Honor, and most humbly in all duty remaine

Your honours during life
at commaund,

John Blagraue.

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To the Reader.

GEntle Reader, it is a most common thing that the mind of any author is so vpon the wing when he endeuoureth to set downe any inuention, that he is ready to alter many things, somtimes in forme, sometimes in matter, at euery new writing of the coppy; and by that meanes many enterlinings do happen to trouble the Printer: wherefore hee that well weigheth either the Authors care or the Printers toyle, may well brooke some few faults to escape. With which whosoeuer disliketh, now that they are here made plaine to be mended, I dare thinke that if himselfe should but write ouer the coppy now perfected, hee might haply make as many ouersights himselfe. Well, halfe an houres time will now make it perfect, which who so will not bestow, I shall thinke my labour ill bestowed for him. I could wish my selfe ready to explaine any doubt.

Yours, Iohn Blagraue.

FOl. 5. line 24 for rested read wrested, fol. 8. lin 25. for from 1 & 6. read from I and C. fol. 11. li. 12. for R G L. read K G L. fol. 16. l. 35. in Zodiack, read in the Zodiacke. fol. 31. lin. 28. for of this, reade of his. fol 37. lin 6. for X C V, read X C W. li. 31. for A X, & A W, read F X and F W. fol 39. l. 18 for through the east. read to the east. fol. 48. l. 15. for at Y so is K C Y, read at I so is K C I. lin 27. for M C N read L C. fol. 49. l. 26. for declineth r. declining l. 27. for line A C r. admit r. line admit. fol. 51. l. 30. for or by G Z. r. or G Z. fol. 53. l. 11. for fifth r. fix l. 33. for L I and L R & L Q & L P & L O. r. L T. & L V, and L W, & L X & L K, fol 67. l. 2, for specially r. and specially. l. 5. for and then r. then fol. 68. l 22. for B. W. r. B V. fol. 69. l. 16 for A F by. r. A. F be. fol 70. l. 13. for F. r. E. fol 71. l. 6. for B H M r. B H in. fol. 72. l 5 for Y B C r. Y B X l. 11. for B Y. r. B X l. 26. for the alliot. r. Alliot. fol. 75. l. 20. for as B D. r. as A D. fol. 79. l. 22. for as the 23 r. as in the 23. fol. 84. l. 3. for of the r. and the. fol. 86. l. 9. for C or B. r. C P or B fol. 87. l. 15. for 90. r. 9. l. 26. for C. E. r. C. P. fol. 91. l. 2. for on O D. r. on D. l. 3. for L M O N. r. L O. fol. 92. l. 31. for M A W. r. in A W. fol. 98. l. 14. for with G E. r. then on G with G E. l. 15. for at I. r. at T. fol. 99. l. 19. for to L I. r. to L. K. fol. 101. l. 28. for and before the r. and the fol. 102. l. 10. for in L D r. A D. l. 12. for B C r. in B C. fol 113. l 12. for Zenith E 23 degrees viz. E Y. &. read Zenith 23 and. fol. 115 l. 32. for K R r. K I. fol. 116 l. 11. for more better. r. more the better. fol. 118. l. 9. for beyond in r. beyond M. fol 127. l. 18. for V E V V. r. V E T. fol 129. l. 1. for S N T. r. N T. l. 2. of S. M. T. r. of N. M T fol. 130. l. 31. for of his centre r. and his centre. fol 133. l. 11. for or dyall. r. murall or reclining dyal. fol. 143. l. 3. for other r. either. fol. 144. l. 14. 17. 18. for part. r. parts. l. 25. for S T V V r. S T V V. fol. 147. l. 30. for all in the. r. all the. l. 31. for line r. lines. fol. 148. l. 10. for ♈ r. and ♈ r. and ♈ fol. 152. l. 16. for canes r. cones.

Faults escaped in cutting the figures of this booke.

IN the figure of the 1. booke, 5. chap. there wanteth 3 letters, viz. S. where the lines M P & A do crosse, and O at the lower end of N O, and R, where N O crosseth A B.

In the figure of the 1. booke 11. chap. the letters S S should be B B.

In the figure of the 1. booke 17. chap. the letter I wanteth hard by V.

In the figure of the 1. booke 23 chap. there wanteth 4. letters, viz. M and N to the ends of the dyametre of the prickt semy-circle, and O and P. to the two notes in the touch-line, I K next vnto G, towards I.

In stead of the second figure in the 1 booke 4 chapter, there should be the 2 figure of the 2 booke, 1 chapter.

In the figure of the 2 book 2 chapter, there lack I & P to the ends of the line ☉ K.

In the figure of the 2. booke 3 chapter there want 5 letters, viz. A at ♈, & I at ☉ & D at the lower end of C O, and B at ♎ and ♈ at the other end of O K.

In stead of the figure of the 2 booke 14 chapter, there should be the figure of the 2 booke 12 chapter.

The figure in the 2 booke 17 chapter is not the right, but you may easily describe the right by the demonstration.

In the figure of the 2 booke 23 chapter, there want 3 letters, viz. B at the flower-deluce, and A at the contrary corner, and X at the lowest corner next the word South, also the word east and west must change places.

In the figure of the 2 booke 24 chapter, the letter T, wanteth a little aboue V.

In the first figure of the 2 booke 25 chapter, P wanteth a little aboue D, and in the figure W wanteth betweene F and I: and in the 3 figure I wanteth at the crossing of O P, with G F.

In the 2. booke, 26 chapter, 2 figure, there wanteth P, where the line Q R F cutteth the dyall circle G O H.

In the figure of the 2 booke 27 chapter, there want six letters, viz. K in the centre of the dyall, and 3 where the excentrick arch X T cutteth K Z, and O where F I cutteth the same arch, and G at the lines end aboue T & D at the other end of the line X 3, a little vnder L, and Q at the corner of the dyals plaine opposite to T.

THE ART OF DY-ALLING.

The first booke teacheth Geometrically, and in a manner Mechanically out of the Theoricke of the Art to make Dials, to all Horizons, and to all Wals or Plaines whatsoeuer, or howsoeuer declining, reclining or inclining, after the plainest manner:

Fit for the Capacity of men of ordinary vnderstanding, *yet differing much from all that hath bene heretofore written of the same Art by any other.*

Chap. 1.

Of certaine principles fitting this Art of Dialling, and of the diuision of all plaines, and their Dials into three sorts, *viz.* Polar, Equinoctiall, and Oblique.

THE Sunne, Moone and Starres, together with the whole heauens, are in euery mans sight turned about from East to West once round in euery 24. howers, by a true equall course, like much in like time that neuer altereth, which diurnall reuolution is performed about a certaine Axtrée line, as G. H. of these three figures: which Axtrée (though to vs inuisible) is permanent and bordereth both the heauens and earth through the middest.

The two ends of which artræ, viz. G. & Y. are called ỳ poles of the woꝛld: so that euery houre is the 24. part of that reuolution, and limmitted on euery Dyall, by the shade of that artræ, oꝛ at least, of a line parrallell thereto, as shall bée shewed.

2 That great circle of the spheare, as C. B. F, whose plaine cutteth the Artræ G. Y. squaꝛe crosse the middest at B. is called the Equinoctiall circle, and is himselfe diuided oꝛ cut with 360. semicircles mæting all at the two poles G. and Y. as these figures shew, and are called Meridians, because some one of them cutteth the South point of euery Hoꝛizon, and euery fiftœnth of them is called an houre circle, which onely in these thꝛée figures we haue described, of the rest we haue no great vse foꝛ this Art.

3 Such is the great compasse and Immensity of the Heauen, that the whole earth in compariſon to it, is but the centre point thereto: and therefoꝛe all Dyals are made as though we did dwell in the center of the earth, and euery plaine howsoeuer scituate is by reason thereof accoumpted all one with the plaine of that great circle of the spheare vnto which it is parralell.

4 The earth is found by trauailers, to be peopled round about, and the flat plaine oꝛ leuell of any place inhabited, as A. C. B. in either of these thꝛée figures whereſoeuer it be scituate round about the earth, is called the Hoꝛizon of that place; But the Hoꝛizon circle of ỳ same place on the spheare, as A. B. B. and his plaine is, (as is said) by reason of the sayd immensity accounted all one with that plaine A. C. B. on the vpper face of the earth.

5 The point of the Heauens directly ouer head in any Hoꝛizon oꝛ place is called the Zenith point thereof, viz. C. and the point directly opposite vnder foote the Nadir, viz. D. & a line dꝛawne oꝛ imagined betwéene them, is called the Verticall line, viz. C. B. D. and is euer perpendicular, oꝛ as a plumme-line to the Hoꝛizon directing from the Zenith, thꝛough the center of the earth, and those two points are

also

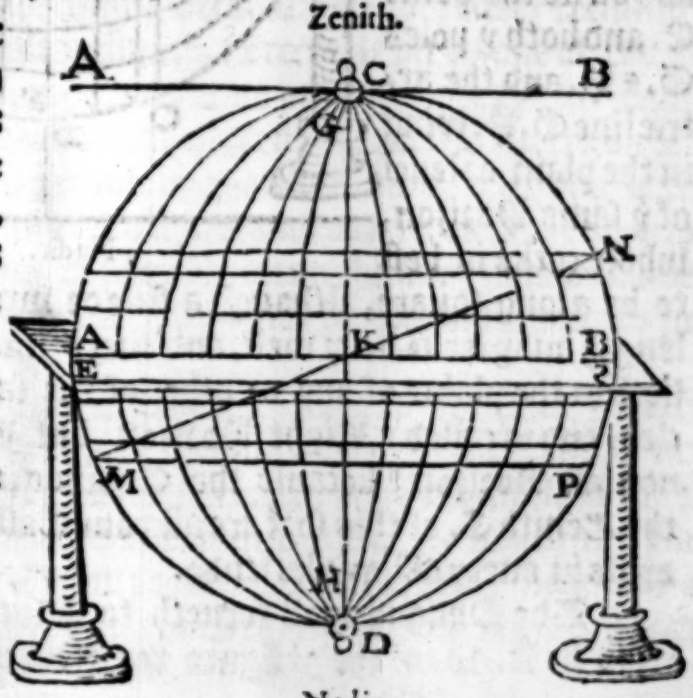
also of Astronomers, called the poles of the Horizon circle: because that point on the spheare, whereon any of his circles are described, is called the pole of the same circle.

6 A line drawne on the plaine of any Horizon, directing to the true North and South, is called the Meridian line, and a line drawne crossing that Meridian square directeth euer to the true East and West points of the same Horizon, and therefore is called the East line.

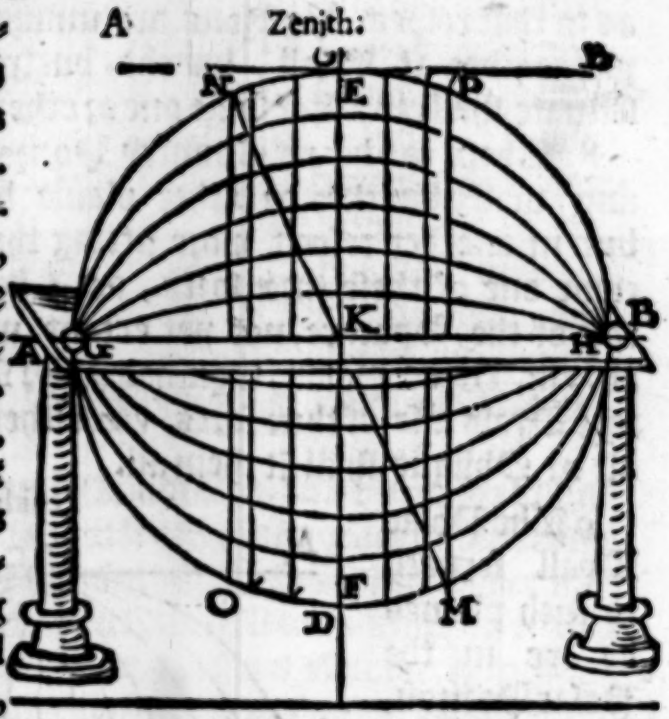
7 Any point in the heauens wheresoeuer round about, may be a Zenith point, and shall haue his seuerall Horizon, so as in that respect Horizons are innumerable, and euery plaine, bee it Wall, bancke, buttresse, &c. howsoeuer scituate, shall represent some one or other of those Horizons.

8 There can bee no Country Horizon or place, no nor any wall, bancke, or other plaine howsoeuer scituate, but in another respect more fitting this purpose, shall become one of these three sorts, as I haue in my Anathomie of the Spheare, not yet extant, more plainely shewed, viz. either Polar, Equinoctiall or Oblique: and therefore Dyals also of three sorts, viz. either Polar, Equinoctiall or Oblique, shall fit them all.

9 The Polar Dyall serueth to such plaines as lye in the Polar Horizon, viz. to such flats as the plaine or Horizon A. B. B. of this first figure representeth, being there all one with the Equinoctial circle E. B. F, which hath the one pole G. di-



rectly in the Zenith C. and the other pole Y. in the Nadir D. and therefore called the Polar Horizon, because it is directly vnder the one Pole, and of this sort can be but two, because the plaine of the Equinoctiall circle E. K. F. hath but two faces: and the cocke of this Dyall is but a stile or pinne plum erected. Of this sort are those that are commonly called (but very vnaptly) Equinoctiall Dyals: for I hold fittest to denominate euery Horizon or plaine, by his worthiest part, which in my conceit is the Vertex or Zenith.

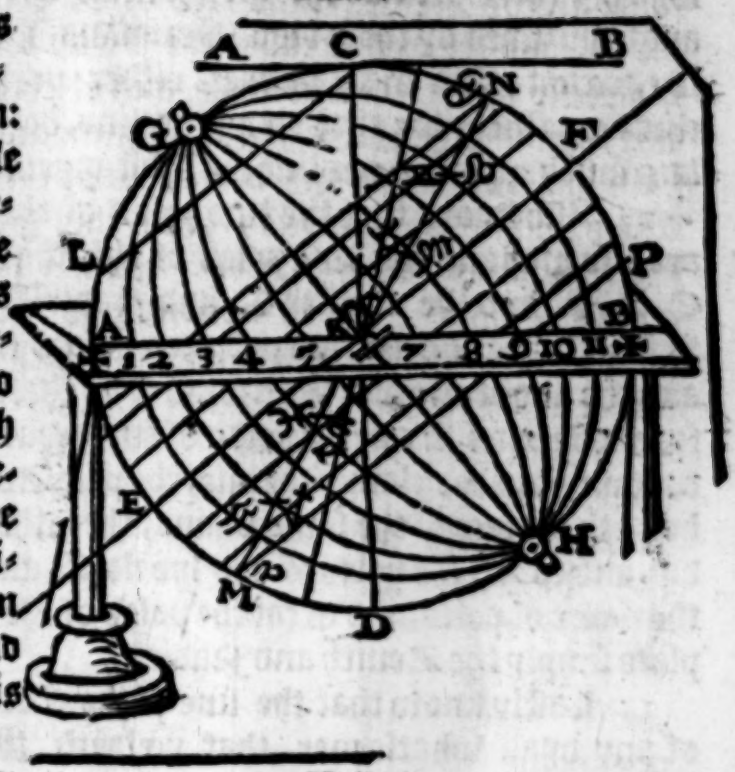


10 The Equinoctiall Dyall serueth to such Flats as the Horizon A. K. B. of the 2. figure representeth, which haue some one point of the Equinoctiall E. K. F. in the Zenith, as you see the point E. and both ỳ poles G. & Y. and the axtree line G. Y. lying in the plain or leuel of ỳ same Horizon, whose cocke is best to be a long square, although a stile or wyer fitted to a iust length may serue very well, and euery such flat or Horizon lieth in the plaine of one or other of the said Meridian circles, and is called a Right Horizon, but I call it an Equinoctiall Horizon, because the Equinoctiall cirkle cutteth the Zenith C. of this sort are all your East and West wall dyals in euery oblique latitude.

11 The Oblique dyall serueth to all such flats as ỳ Horizon A. K. B. of the 3. figure representeth, which haue

one

one of ỹ Poles as G. eleuated aboue them: The other pole Y. as much depressed, whose cock is alwaies a tryangle equall, or like to A. B. G. & such Flats do represent some one oblique Horizon or other in the world. And of this sort is our Horizon heere at Reading, aboue which the North pole G. is eleuated 51. degrees, 35. minutes vz. A. G.



12 Euery declining Wall Dyall, and euery reclining or inclining Dyall declining, (except it hit on one of the sayd two Polar plaines) can be no other then either an Equinoctiall or an Oblique Dyall, rested from the Meridian of the Horizon, represented by that declining, reclining or inclining plaine, whereon it is made to serue vnto the Meridian of the Horizon, or place whereon the same plaine standeth. So that Dyals, as I say, can be but of three sorts howsoeuer.

13 This Rule is generall (well to be noted) in any of those declining Dyals, that line wherein the cocke standeth which hereafter wee call the line of Declination, is the true Meridian of that Horizon in the world, which the plaine whereon the Dyall is made representeth. And the line which sheweth 12. of the clock, is alwaies the Meridian of the Horizon of the place whereon the Dyals plain standeth,

which I therefore call the Horizontall Meridian: and the angle included by those two Meridians, I call the angle of Deflection: And in all plaines either perpendicular, reclining or inclining that do not decline, both these Meridians will happen in one line, as shall appeare.

14 Also know that the two poles of the world G. & H. are also properly the two poles of the Equinoctiall circle E. K. F. and the Zenith C. and Nadir D. of the Horizon A. K. B. are also his two poles, as before is sayd in the 5. and the like of all other Horizons: I do therefore hold it best for a difference to call the poles of any great circle representing any wall or plaine, the one, the pole Zenith, which beholdeth the face of the same plaine, the other, the pole Nadir, and to call the poles of the world G. and H. simply by the name of poles, and to cal the poles of the Horizon of any place simply the Zenith and Nadir.

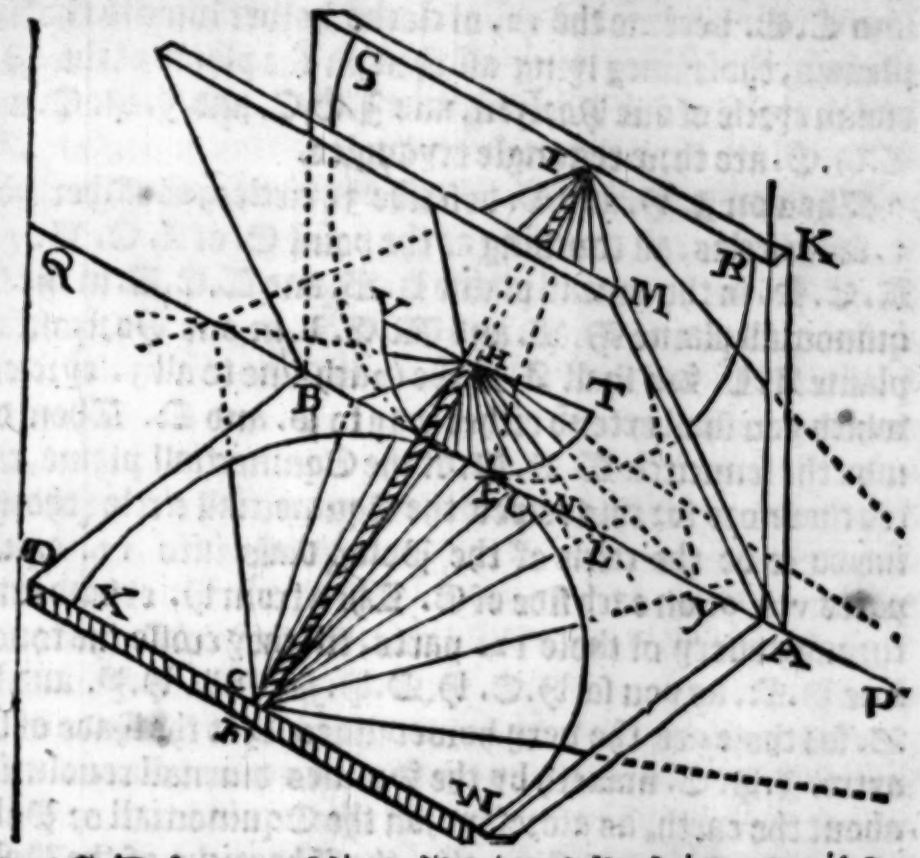
15 Lastly know that the line of the Cocke or Gnomon of any dyall whatsoeuer, that yeldeth the shade to the howers, must lye euen or parralell with the Artræ line of the world G. H, and point directly to both the poles G. and H, as before is sayd.

CHAP. 2.

The Theoricall ground and reason of proiecting and making all Polar and oblique dials geometrically.

A Dyall is nothing else but the description of 24. howe-lines, which the Sunne by his diurnall reuolution proiecteth by the shade of a visible artræ line lying parrallell to the inuisible artræ of the world, on some visible plaine or other that lieth parrallell to the inuisible plaine of some one great cycle of the heauens or other. And because the Equinoctiall cycle E. K. F. in the first Chapter mentioned, is the onely great cycle of the spheare that is described by the same diurnall reuolution: therefore out of him, as from a rote, is deriued the proiectment of those 24. howe-

hower-lines on any other great circle or plaine whatsoeuer: For Example.



Let A. D. be any oblique Horizontall plaine, admit leuell with our Horizon cycle here at Reading. Let his one side A. B. serue for the East line and square, to it draw the Meridian line E. F. Then let there stand on the East line A. B. two other plaines, the one a murall plaine as B. K. perpendicular erected on the Horizontall plaine A. D, the other B. M. an inclining plaine eleuated aboue it, so much as the Equinoctials height with vs commeth vnto, which is 38. degrees 25. minutes, viz. according to B. F. of the 3. figure of the 1. Chapter. Then thrust a pinne, stile or wyer of infinite length through some point, as M. of that Equinoctiall plaine B. M. chosen directly ouer the Meridian E. F. so that the same pinne stand square to B. M, so shall it of necessity lye in the axtree line of the world, and withall broach through the Horizontall plaine A. D. at C, and the murall

murall plaine B.K. at I. Then draw the lines Y.E. and I.E. both perpend. to A.B. And so are I.E. and Y.E. and C.E. become the 12. of clocke hower lines to those 3. plaines, those lines lying all three in the plaine of the Meridian cycle of our Horizon, and I.E.C. and I.Y.C. and C.Y.E. are three rectangle tryangles.

Then on I.Y. and C. describe 3. circles, or rather here 3. semicircles, all touching at the point E. of A.E.B. viz. K.E.S. in the murall plaine K.B. and T.E.V. in the Equinoctiall plaine Y.B. and W.E.X. in our Horizontall plaine A.L. So shall A.B. be touch-line to all 3. cycles, which you shall extend either way to P. and M. Then deuide the semicircle T.E.V. of the Equinoctiall plaine, called therefore for this respect the Equinoctiall circle (though indeed it be the circle of the Polar dials into 12. equall parts viz. 6. on each side of E. Then from Y. extend lines through euery of those 12. parts, till they crosse the touch-line P.M. as you see Y.E. Y.D. Y.N. Y.L. Y.P. and Y.Z. for those are the very hower-lines, that the shade of the arture I.Y.C. maketh by the Sunnes diurnall reuolution about the earth, as aforesayd, on the Equinoctiall or Polar plaine Y.B. manifesting also the Theoricke of the Polar diall: for indeed the Polar Horizon is of some called Horizon obliquissimus.

Lastly, from 1. and 6. extend lines vnto all those crossing at D.N.L.P. and Z. and those shall furnish you with hower-lines for both the other dials, as you see. The reason is, because the hower-lines projected by the selfe same shade of the arture I.Y.C. on the murall plaine K.B. and on the Horizontall plaine A.D. must of necessity crosse all at the touch-line P.M. because the line P.M. lieth in euery one of their plaines, and is the common section to those three great circles of the spheare, which these three plaines represent, that is to say, they do all three crosse one another on that line P.M.

Note that if the Equinoctiall plaine B.Y. be let downe

to

to the Horizontall plaine, A. D. or clap vp close to the mu-rall plaine, B. K. yet shall all the lines before extended from Y. through the 12. parts of T. E. A. cut the touch-line P. M. in the selfe same points, whereby you may eas-ily conceaue why in making euery Oblique Dyal, the line-aments, are deducted out of an Equinoctiall circle, fitting to it, & lying in the selfe same plaine, as hereafter will appeare.

Chap. 3.

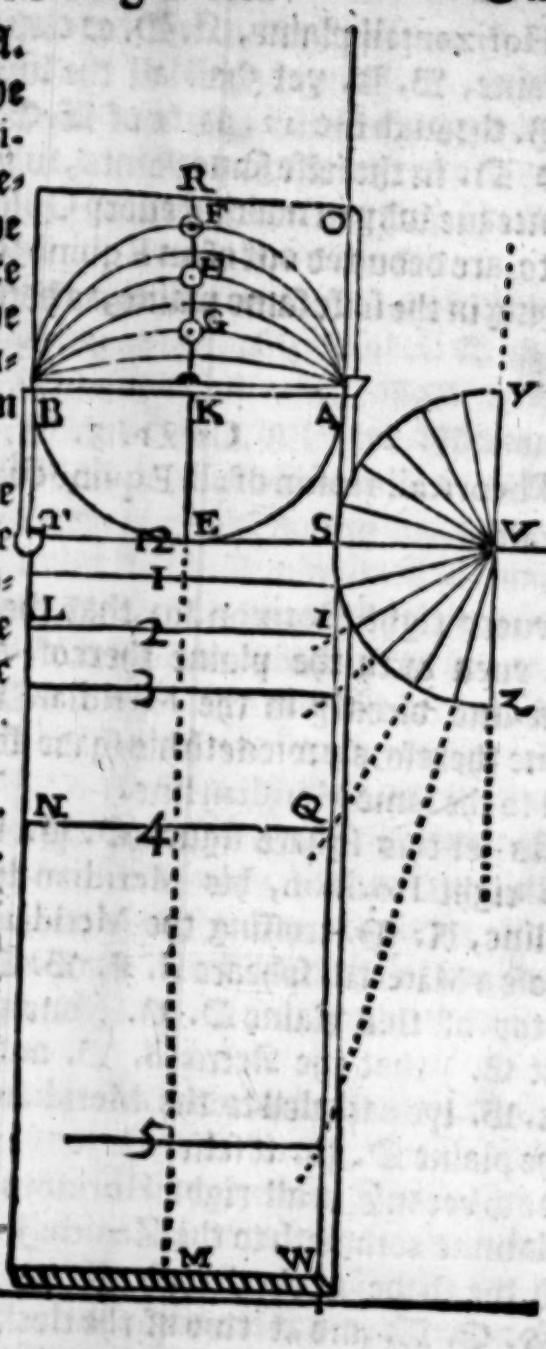
The Theoricall reason of all Equinoctiall or right Horizon Dyals.

IN euery right Horizon, for that the poles of the world lye euen with the plaine thereof, as is said, and the Artrée-line directly in the Meridian line thereof. The Sunne therefore proiecteth his shade for euery hower par-ralell to the same Meridian line.

As let this square figure D. P. lye in the plaine of some right Horizon, his Meridian line S. T. and his East line, K. M. crossing the Meridian square at E. Then suppose a Materiall spheare A. F. B. E. to be so planted on the top of this plaine D. P. (onely touching it at the point E.) that the Artrée A. B. and the Horizon circle A. K. B. lye parralell to the Meridian line S. E. T. and to the plaine D. P. it selfe.

Now because in all right Horizons euery day at none the Sunne commeth to the Zenith F. It therefore proie-cteth the shade of the Artrée, A. B. iust on the Meridi-an S. E. T. and at two of the clock being descended to the hower circle, A. H. B. it proiecteth the shade I. L. of the two of clocke hower-line parralell also to S. T. and at foure of clocke, being descended to G. of the hower circle A. G. B. it there proiecteth the foure of clock hower-line, N. M. But at six of clocke, being descen-ded to K. of the hower circle A. K. B. which is all one with

the Horizon circle A. K. B. euen with the brinke of the Horizon, then it proiecteth the shade of the Arctæ A. B. infinite viz. so leuell with the Horizon that it vanisheth quite off from it.



And heere doth the line K. Y. supply the touch-line as wil appeare, if in the same plaine you extend the Meridian T. S. to V. and therein take V S. equall to K. C. & on V. with V. S. describe a Semi-circle Y. S. Z. equall to A. C. B. and draw D. S. W. parralell to K. Y. for a touch-line therto, and then diuide V. S. Z. into twelue equall parts, by which from V. extending lines, they shall cut the touch-line D. W. euen w̄ the hower-lines before drawen: for though the Semi-circle Y. S. Z. lye in the plaine of D. P. yet the Radiall lines extended from V. doe crosse the touch-line D. W. in such sort as if Y. S. Z. stood perpendicular on the plaine D. P.

CHAP. 4.

Chap. 4.

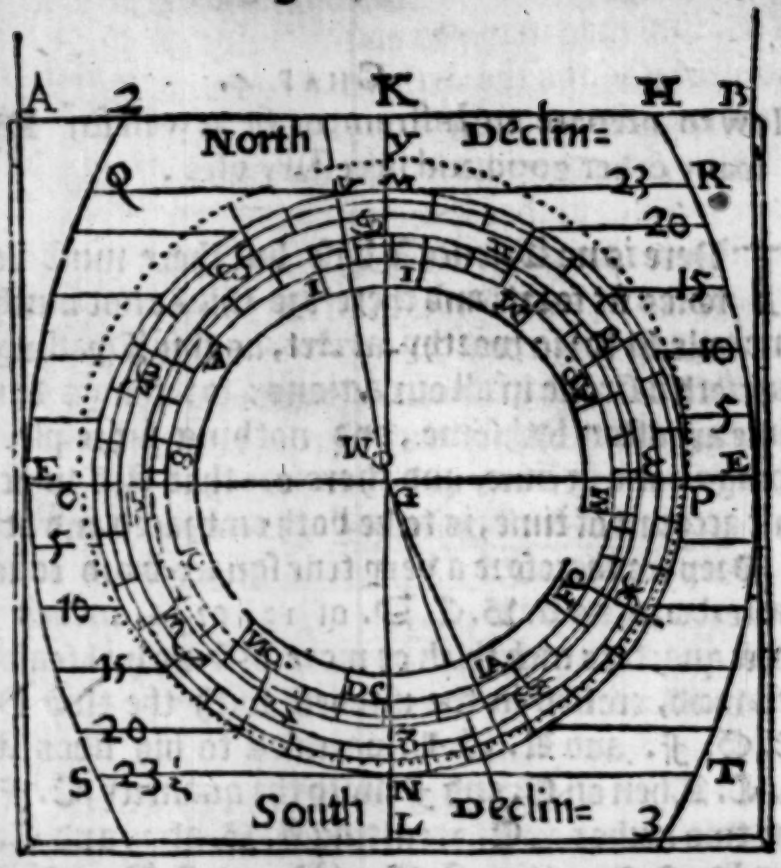
How to prepare an Instrument fit as well for Dyalling, as many other good and necessary vses.

There is no Science so base, but there must bee framed toles fit for it, and therefore thinke not much to make one tole fit for so worthy an Art, as this Dyalling is, which carrieth a stroke in all our actions: for things done out of time are often lothsome, and nothing more pleasing then things done in time; and therefore that Art which keepeth iust account of time, is to be both embraced and admired.

Prepare therefore a very true square-bord couered with paste-bord, as A. B. C. D. of 12. or 16. inches side, and three quarters inch thick or more, of some wel seasoned quarter-wood, crossed in the middest with the two Dyametres E. G. F. and R. G. L. parralell to his sides A. B. and A. C. Then on E. and F with the quantity, E. F. describe the two arches 2. E. 3. cutting A. B. at 2. and C. D. at 3. and H. F. I. cutting A. B. at H. and C D. at I. Then diuide the arches E. 2. and E. 3. and F. H. and F. I. each into 30. equall parts or degrees, numbred from E. and F. Of which degrees let E. M. and E. S. and F. K. & F. T. be each of them 23. degrees and an halfe, then draw M. K. and S. T. then on G. describe the circle, M. N. P. O. touching M. K. at N. and S. T. at O. and crossing E. F. at M. and P. This circle M N. P. O. shall bee called the Cliptick circle, & must be diuided into 12. equal parts, for the twelue signes of the Zodiack, and each signe into 30. degrees, so that Aries begin at P. and Cancer at N. and Libra at M. and Capricornus at O. the rest in order handsomely done limblike, and numbred as here you see.

Then shall you draw parralels to E. F. through euery degree of the arches, S. M. and T. K, by a rule laid on the match degrees of either. These parralels must touch and not crosse ỹ Cliptick circle M. N. P. O. & must be numbred both

wales from ☉ ♐. ending at ♑. ♓. & ♋. ♑. with 23.½ as heere you see done: so doth ☉. ♐. represent the Equinoctial circle, & ♑. ♓. & ♋. ♑. the two Tropicks. and the parrallels, betweén them, the parralels of the suns declination from ☉. ♐. Then write this word, North Declinations to those aboue ☉. ♐. towards Cancer, and South Declination to those below.



This done, describe two or three circles more within this Zodiacke limbe, to make a Kalender limbe. Then lay a rule from ♋. on the tenth degrée of Cancer: and thereby draw the line ♋. ♑. then take in your compasse one degrée 50. minutes of the circle, ♑. ♓. ♈. ♎. and set the same in ♋. ♑. at ♑. and on this point ♑. with the quantity ♋. ♓. describe a blind excentrick circle, ♑. ♈. then laying a rule from ♋. on the 21. degrée of Capricornus, you shall crosse that Excentricke ♑. ♈. at ♑. with the line ♋. ♑. then from this point ♑. towards ♈. and so round, you shall diuide that Excentricke circle ♑. ♈. into 365. equall parts, and one quarter; which to do with the more ease, you shall reckon fiue degrées ten minutes, from ♑. towards ♎. there set

set Z. and then may you easily diuide ♈. ♑. Z. into 360. equall parts, and the Arch, Z. ♈. into 5. ¼ parts, if you wil be curious; so haue you 365. ¼.

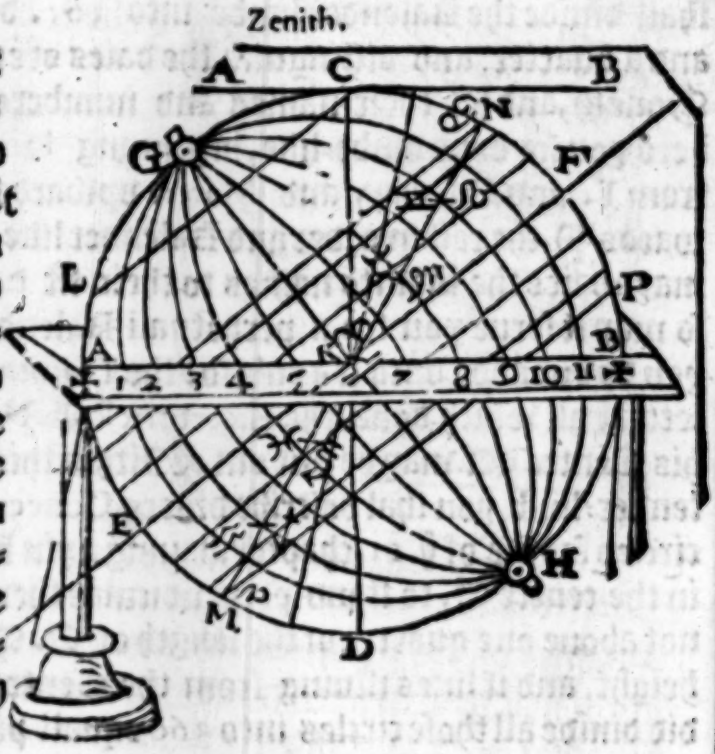
Lastly, by a rule laid frō G. on euery of those 365. ¼ parts of that Excentricke ♈. ♑. Z. you shall diuide the Kalender limbe into 365. daies and a quarter, and distinguish the daies of euery Moneth, and set their names and numbers as here you see done limbe-like, beginning Ianuary from ♈. and February and March vpwards towards ♑. the rest in order and Kalender like, you may write the Saints names to their fit daies: so may it serue you for a perpetuall Kalender, if you do but adde vnto it a rule for the Dominicall letter, all which done, the Excentrick ♈. ♑. and his Centre W. may be put out. Within this Kalender-limb, you shal describe diuers Concentrik circles for vse of ỹ 11. chapter, hauing a pin fitted in the centre G. to stand perpendicular thereon, not aboue one quarter of the length of G. ♑. in height, and if lines issuing from the Centre G. did diuide all those circles into 360 equall parts, or one quarter of them into 90. they would serue the 8. Chapter well.

On the back side of this Instrument, you shal as the 2. Booke, 1. Chapter teacheth, describe a large Quadrant of a circle, as A. B. D. let his limbe B. D. be diuided into 90. equall degrées, & each degrée into 6. equal parts, fitted limblike, as here you see & numbred both waies, viz. frō D. ending at B. wt 90. & frō B. ending at D. wt 90.

Let this Quadrant haue a labell, as A. E. G. with sights fitted to him: all which is vsuall, and therefore this simple picture may suffice. Your instrument thus finished, shall be an ornament in the house, and a ready tole for a number of vses and fitting a number of actions.

CHAP. 5.

How by this Instrument, any day of the yeare, to know the signe and degree of the ☉ in the Zodiack, and how much his Declination is.



BEing that the sun is ỹ master guid of this Art it behoueth you first to know he hath in apparance two motions: the one his owne proper motion perfo3med euery yeare once about the heauens, th3ough all the 12. signes: vpon which the Fabrication of our Dyals doth depend. The other a Collateral motiõ perfo3med euery day once about ỹ earth, by a certain power of the Almighty, set in the Primum nobile o3 second heauen, as the old Philosophers affirme, which carrieth about Raptim, not onely the Sunne, Moone, and Starres, but the whole Heauens also euery 24. how3es once, vpon which motion, the vse of all Dyals dependeth after they are made.

The sunne by his said proper motion, traceth out yearely a certaine circle in the heauens, as M. B. N. in this figure called the Ecliptick, lying Byas, o3 inclining to the Equinoctiall circle, E. B. F. 23. degrées, 30. minutes, acco3ding

ding to the Arch ♑. ♐. or ♋. ♓.

And although the Sunne be a whole yeare in going about the Cliptricke circle ♓. ♓. ♑. yet the said Collaterall motion causeth him euery day in a manner to describe or trace out a seuerall circle, and euery one parralell to the Equinoctiall ♋. ♓. ♐. which therefore are called parrales of the Sunnes declination.

As for example, with vs in middle of Summer, when as indæde the Sunne is in the first degree of 69. viz. in ♑. which happeneth yearely about the twelue of June. Yée is, I say then, by that Diurnall motion, carryed about the Artrée ♋. ♓. all that day in the Tropicke circle or parralell ♎. ♑ and the nert day, and the nert, as the Sunne by his owne proper motion passeth from ♑. towards ♓. he is carried about by that other motion, in other circles parralell to the same. And that day at nœne, being at ♑ he is at the very highest that may be, aboue the Horizon ♈. ♎. of our latitude, viz according to the Arch ♑. ♎. which Arch is called his Meridian altitude for that day.

Againe, in mid-winter, about the 12. of December, when entering ỹ at ♓. he is carried in the other Tropicke parralel, ♓. ♍. he is at nœne much lower & nérer to ỹ Horizon, ♈. ♎. viz. at ♍. his Meridian altitude being then ♍. ♎. in the first making the day viz. ♓. ♑. much longer then the night, viz. ♎. ♓. for the Diurnall passage of the ☉. aboue the Horizon, ♈. ♎. viz. ♓. ♑. must nœdes make the day, and that vnderneath viz. ♎. ♓. the night. In the second, the night, viz. ♓. ♋. longer then the day, viz. ♋. ♍. and thus it appeareth how the dayes lengthen and shorten all the yeare.

But there is two middle times, one about the 12. of March, when the Sunne commeth to Aries, viz. at ♓. and the other the 12. of September, when he commeth to Libra, viz. at ♓. returning: at which two times the day ♓. ♐. is iust equall to the night, ♋. ♓. called therefore the Equinoctium, on which two dayes the Sunne by his said Collaterall

terall or Diurnall reuolution traceth out the Equinoctiall circle, E. K. F. and vpon those two daies at none, the Meridian Altitude of the Sunne, F. B. is equall to the eleuation of the Equinoctiall, E. K. F. aboue the Horizon A. K. B. and both equall to G. C. the complement of the eleuation of the pole G. aboue the Horizon: for A. G. and G. C. or F. B. equall to it, doe alwaies make 90. degrées.

Now therefore to the matter: Sée any day at none, how much the Meridian altitude of the Sunne, differeth from that Equinoctiall height, B F. the same is called the declination of the Sunne, or more plainely of the parrallel, which the Sunne traceth out that day: And at such times of the yeare as the Suns Meridian altitude, is found greater then this Equinoctiall height (as B. N. which is greater then B F.) then in this part of the world, where the North-pole G. is eleuated that declination, viz. F. N. is called North declination, viz. because D. N. the Sunnes parrallell traced out that day, lieth betwéen the North-pole G. and the Equinoctiall E. F. and in that case the Equinoctiall height, B. F. taken out of ỳ Meridian altitude, B. N. leaueth the declination F. N. knowen. But when the Meridian altitude, as B. P. is found lesse then the Equinoctiall height, B. F. Then is the declination F. P. called South, because the Sunnes parrallell traced that day, viz. P. P. lyeth betwéene the South pole Y. and the Equinoctiall E. F. and in that case the Meridian altitude P. B. must be taken out of the Equinoctiall height F. B. so resteth F. P. the declination. By all which, the reason of our instrument may easily appeare.

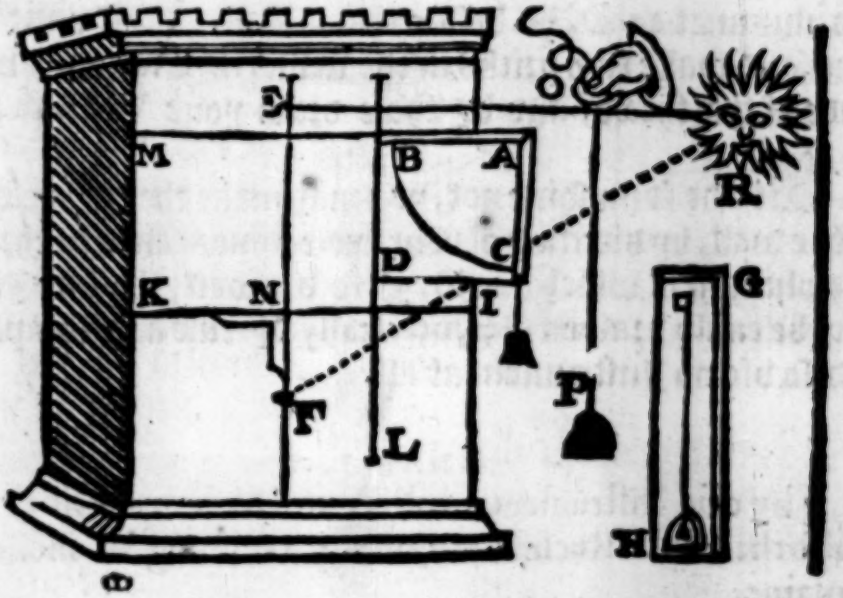
When as therefore the place of the Sunne or his declination is desired for any day of the yeare, admit for the second of August, you shall but extend a thréd out of the Centre G. of the instrument, on the beginning of the second day of August, sought in the Kalender limbe, and there shal the thréd shew you in Zodiacke limbe, 20. degrées in Leo, being the signe and degrée that the Sunne occupieth that day at

at none desired. And then marke what parrallell of declination doth there cut that twenty degrée of ♌ so found, which you shall find to be the 15. parrallell. Therefore I say, the declination of the Sunne on the second of August is 15. degrées, and that North-ward from the Equinoctiall, as the words North declinations and South declinations written on the Instrument, doth sufficiently manifest.

Hitherto we haue but laid the ground-worke of this Art, as briefly as might be. Now will we proceed with the workemanship.

Chap. 6.

How by helpe of this Instrument to draw a verticall-line, and an Horizontall-line on any perpendicular wall.



A Verticall-line is but that which the common sort call a plumme-line, as E. F. it can be drawne no where but on a Wall or poste plumme-erected, and may be most easily done by helpe of a Masons plumme-rule, as G. H. applied to the wall.

An Horizontall-line, is a line drawen leuell with the plaine of your Horizon, and being drawen on any Wall,

plum-erected, shall crosse the Verticall-line square, as I. K. which by a plaine squire applyed to the Verticall-line is sone done, as here you see at N.

But to be done by your Instrument, you shall apply it plaine to the wall, so that some part of him may lye without the wall, to giue your plummet rome to play: and settle him so to and fro vntill the thread and plummet hang euen with the Quadrants side, A. C. which done you may easily by his hanging side B. D. strike a Verticall-line as B. D. L. and by his leuell side, A. B. strike an Horizontall line, A. B. M. Thus you see your instrument serueth very fit both for a Masons leuel, and for a plaine squire.

My selfe by dayly practise did often finde readyer meanes then ordinary, for a number of things namely in this. If the Wall be very plum-vpright, then hang a black thread and plummet as D. B. before the Wall, the Sunne shining, and make two pricks in the wall, viz E. and F. in the shade of the thread, and by those drawe your Verticall line E. F.

Or if the Sun shine not, you may make the two prickes in the wall, by direction of your eye-beames, and the thread and plummet: which line E. F. so drawen, the line I. K. may be easily drawen Geometrically by rule and compasse, and so vse no Instrument at all.

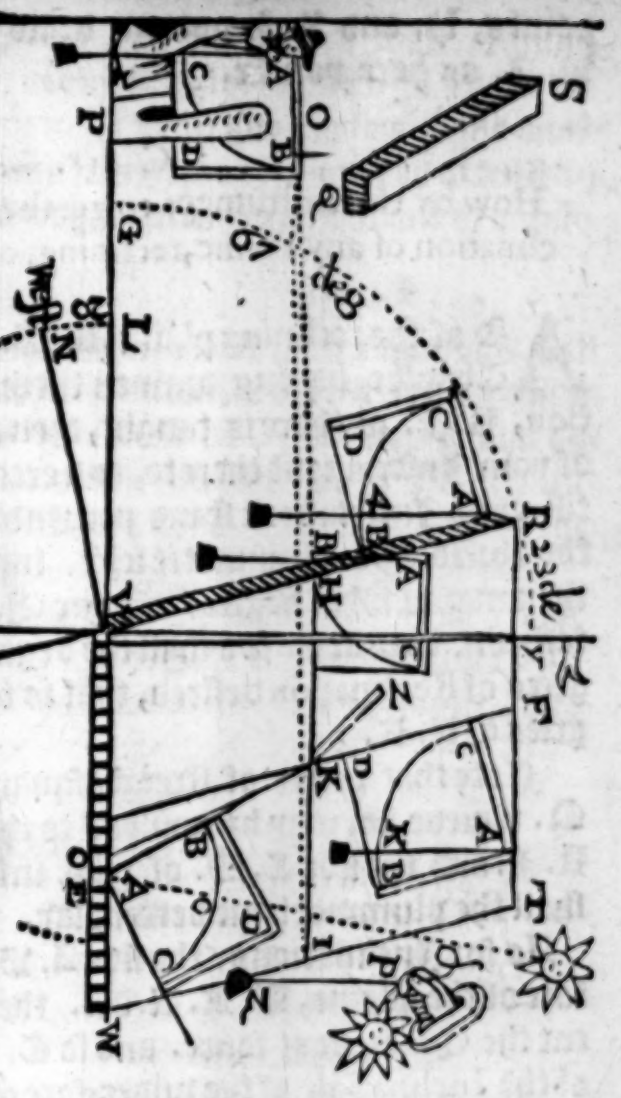
CHAP. 7.

How by this Instrument to draw an Horizontall line, and also the line of Reclination, on any reclining or inclining plaine.

ANy plaine, be it Banke, Buttresse, or any other that standeth not perpendicular erected, on the face or plaine of your Horizon, if he batter or leane backwards, is called a reclining plaine, if he ouer-hang or leane forewards it is called an inclining plaine.

In this figure let P. W. be the plaine of your Horizon, and

and let V. Y. bee a Verticall line thereon plumme-erected, and let R. T. V. W. bee a plaine reclining frō that Verticall line V. Y. according to the Arch, Y. R. on which plaine to drawe an Horizontall line, you shal nere to one side, viz. at Y. place the side, B. D. of your instrument, & there settle it till the threed and plummet hang euen with the hanging side A. B. for then shal that side B. D. be leuell with the Horizon, by which you shall extend the Horizontall line, Y. D. R. I. desired: which drawen you shall drawe the line R. F. square thereto, euen as in the 6. Chapter you did draw the Horizontall line square to the Verticall, which line R. F. so drawen, is called the line of Reclination.



Another ready way I practised thus. Pitch a cleft stake as D. Y. before your plaine R. T. V. W. and put your instrument into the clift, there keeping the side A. T. Vertical by help of the threed & plummet, direct the leuell side A. B. to the plaine, where let your eye-beame first guide you to the point Y. and after turning about the stake let it direct you to some point beyond Y. viz. to I. By which

points, Y. and I. so gotten, draw your Horizontall line Y. I. as here you see.

CHAP. 8.

How by this instrument to get the true Reclination or inclination of any Plaine, reclining, or inclining.

AS of the reclining plaine, K. T. V. W. of the seuenth Chapter, hauing drawen thereon the line of Reclination, K. F. as there is taught, then apply the side T. D. of your Instrument thereto, and erect the other side A. B. till your Instrument stand perpendicular thereon, which the thread and plummet it selfe, will helpe you to do; and then marke what degrees of your Quadrant the thread cutteth on, viz. at E. So shall the degrees of B. E. be the degrees of Reclination desired, that is to say, equall to the degrees of Y. K.

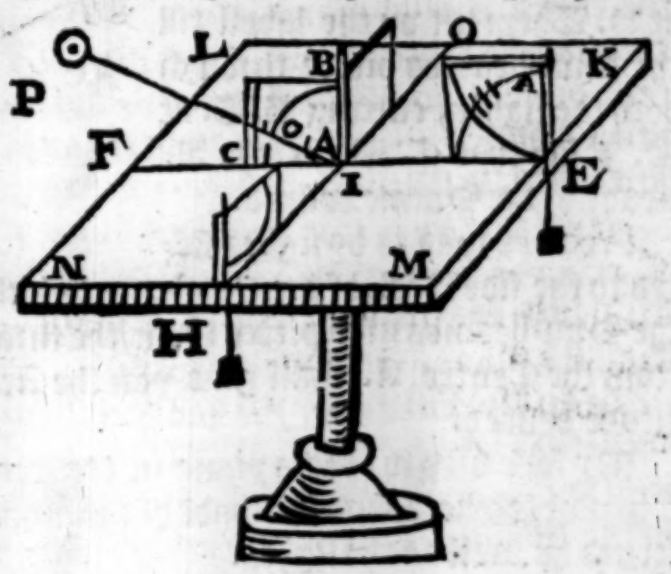
Note that a peece of streight squared timber, like to S. M. if neede be, may be applyed to the line of Reclination, K. F. and the side T. D. of your instrument to that: So shall the plummet haue better play.

As for Inclinations, the side A. B. applyed to the vnder face of the plaine, T. K. V. W. the line and plummet shal cut the Quadrant at foure. and so T. foure, are the degrees of the Inclination of the vnder-face of that plaine K. T. V. W. desired, whereby it appeareth that the angle of Inclination of the vnder-face of any plaine, is but the complement of the Reclination of the vpper-face; for B. 4. is equall to B. E. before, and B. 4. and 4. T. make 90. degrees, wherefore hauing gotten the degrees of the one, those taken out of 90. leaueth the other. Note that as Y. K. is the Reclination: so L. M. is the declination, but of these we shall haue no vse in this first Booke, onely I thought fit to shew the vse of the Instrument.

Chap. 9.

How by this Instrument to set any plain leuell with the Horizon, and how to set any stile or pinne, or the cocke of any Dyall, perpendicular or plumme, on any plaine.

IT is by the fire, seuen, and eight Chapters manifest, that this our Instrument truly made square, serueth both in stede of a squire, and a Masons leuell. Now let B. N. be a plaine proposed to be set leuell, you haue therefore no more to doe, but to draw two lines, as G. Y. and E. F. thereon crossing each other square at I. it is no matter in what place, & thē leuell it twice by the thred and plummet, as in the fir and seuen Chapters was done, viz. first in the one line G. Y. admit at Y. then in the other line, E. F. at E. or F. till you find both leuels to agree, and you haue done. But for erecting a stile, be sure that your two lines, G. Y. and E. F. do crosse iust in the point I. where the pin shall stand; & then apply your Instrument squire-wise, close to the pinne at I. first in the one line E. F. then in the other G. Y. till you haue set him vpright. All which, this bare figure sufficiently sheweth: For a Dyall Cocke you must apply your squire thereto, in a line crossing square the line where the cocke standeth.



CHAP. 10.

How by this Instrument to take the height of the Sunne aboue the Horizon, two seuerall waies.

THe generall way best fitting our purposes is thus. Get some bord or plaine set leuell with the Horizon, as B. N. of the last Chapter, thereon plant the side A.C. of your Instrument directing the Quadrants limbe B. C. to the Sun at P. There lift vp the labell till the Sun-beames pierce through both the sights, cutting B. C. at D. I say that C. D. is the altitude of the Sunne desired.

A readier way is by sights fitted to the side A. C. of the Quadrant, which so directed, that the Sun-beames may pierce them, the threede and plummet from the Centre, A. shall giue you the Arch, B. D. the altitude desired.

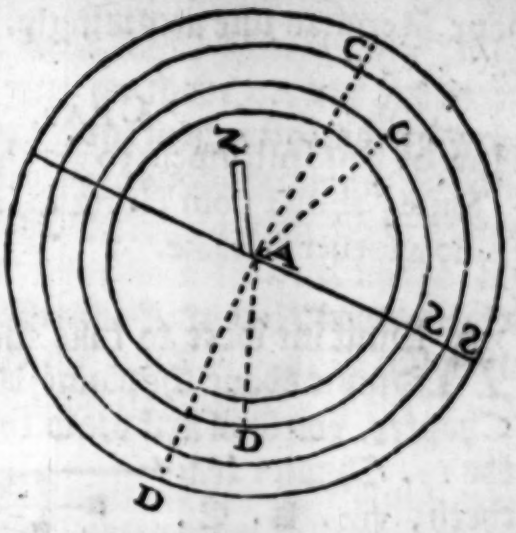
My selfe vsed to erect a pinne in the centre A. as the 9. Chapter teacheth, and the shade of the pinne falling on A.C. serued as well as the sights.

CHAP. 11.

How any day the Sunne shining, the Meridian line of any Horizon or other plaine, howsoeuer scituate, may be gotten by this instrument.

YOu shall on your plaine, whether it be Murall, Horizontall, or any way declining, reclining, or inclining, pitch a center point, viz. A, wherein erect a stile or wier plum-vpright

right, as the 9. chap. teacheth. About which two or three circles being first described, you shall then watch in the morning when and where ỳ shade of the stiles top toucheth the ring of any of them, there set D, againe as much after noone, watch when the stiles shade toucheth the same circle, againe there set C. then



deuide that Arch D. C. in the middest at B. and draw B. A, the same shall be the Meridian desired.

Another way, thus you may in the morning take the altitude of the Sunne, as the 10. Chap. teacheth, admit tenne degrees, and the same instant set a pricke where the shade of the stiles top resteth on the plaine, admit at D. neither is it now materiall, whether any circle be described or no, then as much after noone, setting your quadrant in a rest, watch till the Sunne descend iustly to the same height againe, viz. to ten degrees higher, and then set another prick at the shade of the stiles top, viz. at C. then draw the line C. D. & crosse it square with another, as B. A. which shall both crosse the Center A. and be the Meridian sought.

Note that it is best to obserue it at 2. or 3. circles or times in the morning, least the Sunne in a cloud in the after noone should deceiue you, if you obserue but once.

The Meridian thus gotten on all walles or plaines, declining or reclining, wee call the Meridian of the wall or plaine, or rather in the second booke, the line of diffierion, for therein alwaies the cock must stand.

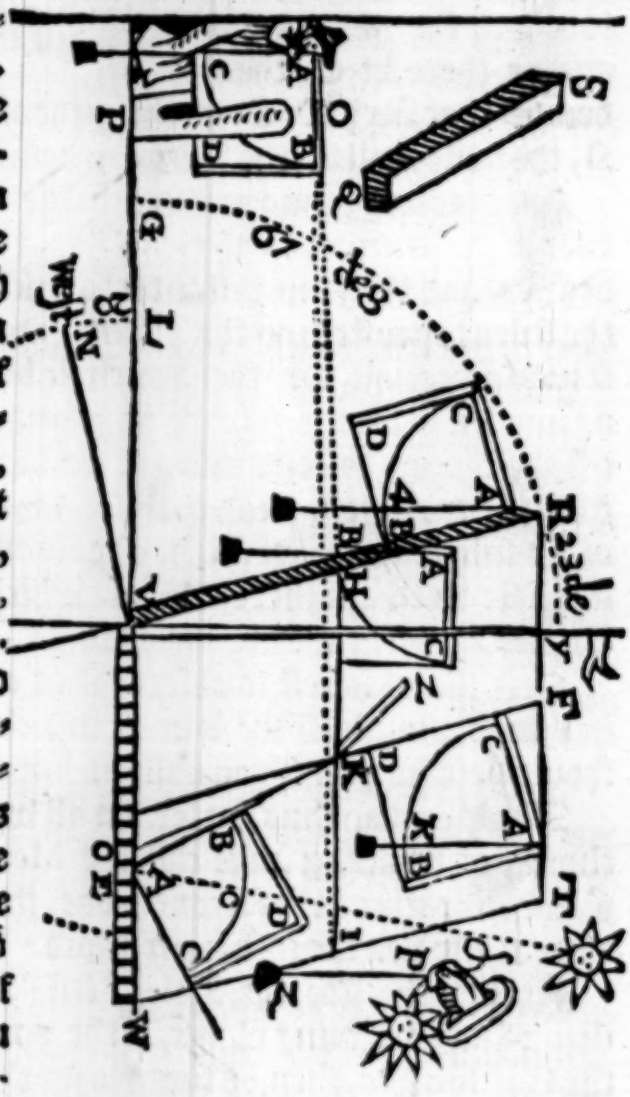
Note on this side the Equinoctiall, in getting the Meridian of any reclining plaine, if the point B. happen vnder the Horison line, then be sure the south pole is elevated, if

aboue then the north pole: and therefore you must draw your Meridian line accordingly.

CHAP. 12.

How by this Instrument to get the Meridian altitude of the Sunne aboue your Horizon, or aboue any other plaine, howsoeuer Scituate.

ADmit we were to take the Meridian altitude of the Sunne aboue the plaine K. T. H. W. of the seauenth Chapter, you shall first draw thereon the Meridian line, as the 11. Chapter teacheth, viz. K. E. and therein plant the one side of your Quadrant, and erect him plumme from the plaine, as the ninth Chapter teacheth, on this condition, that if the Meridian fall vnder the Horizon line, turne the quadrant vpwards, if aboue, then downewards, his one side as A.C. so iustly in K.E. and the limbe of the quadrant tourned towards ỳ Sunne, as here you see. There must you support the Quadrant either wᵭ some prop fitted of purpose, or else you may nayle the Quadrant



drant to one side of a square peece of timber, as D. S. and fasten that in the Meridian, K. E. which done, watch vntill you see that the Quadrant giue no shade on the plaine, or more plainely till the Sunne come so directly with ỹ Quadrant edge-long, that it proiect the whole shade on the Meridian line K. E: for then is your time to take your Meridian height, and not before: wherefore then lift vp the label till the sunne beames pierce both the sight holes, & take the degrees there shewed by the label, viz. at D. counted from the Meridian K. E. viz. B. D. the same is the Meridian altitude desired.

Note that with a thred and plummet in your hand, you may often assay when the shade of the thred will fall iust in the Meridian K. E. which when it doth, then is your time. The same may you doe by the shade of a stile erected as K. Z. in the Meridian K. E.

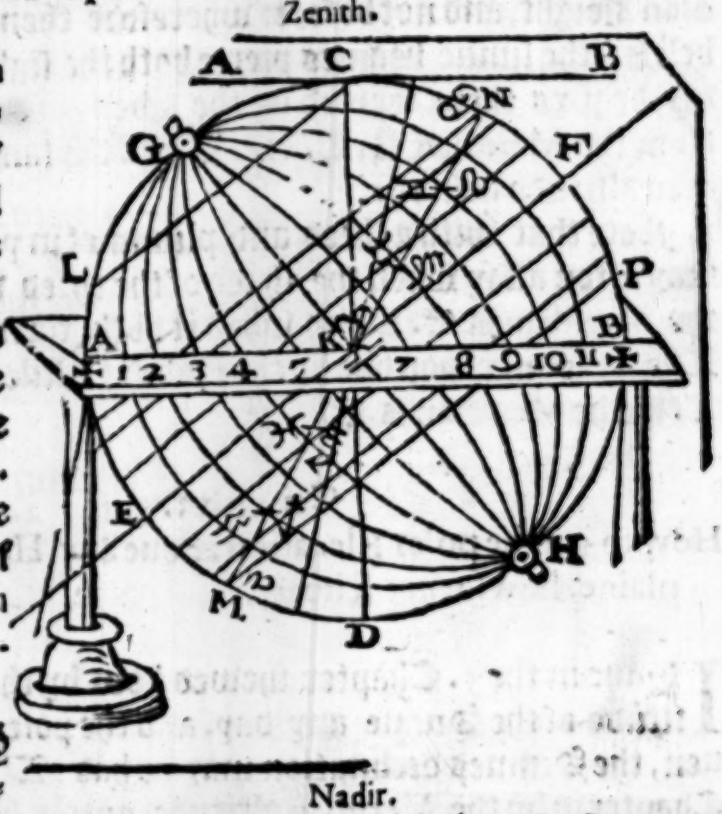
Chap. 13.

How to get the poles Eleuation aboue any Horizon, wall or plaine, howsoeuer scituate.

I Haue in the 5. Chapter shewed how by the Meridian altitude of the Sunne any day, and the poles eleuation giuen, the Sunnes declination may be had: The scope of this Chapter is by the Meridian altitude, gotten by the 12. Cha. and the Sunnes declination gotten by the 5. Chapter. to get the poles eleuation aboue any Horizon or plaine, howsoeuer scituate.

As for example: Suppose our eleuation here at Reading were vnknowne, and that on the 12. of June I should go about to attaine the same. First by the 5. Chapter I finde the declination of the Sunne that day to be 23. degrees, 30. minutes northward, viz. he traceth out then the Tropicke parrallell D. R. N of the figure of the 5. Chapter, his declination being there the arch N. F. Now admit the same day by the 12. Chapter, that I doe finde the Meridian altitude

of the ☉ aboue our Horizon 61. degrées, 55. minutes, so much then the arch N. B. must nœds be. Take therefore the declination N. F. 23. degrées, 30. minutes, out of the Meridian altitude N. B. 61. degrées, 55. minutes, so resteth F. B. 38. degrées 25. minutes, the Equinoctiall height which is alwaies equall to G. C. the distance of the eleuated pole G. from ỳ Zenith C. the complement whereof A. G. shall therefore bee 51. degrées 35 minutes, and so much is the height of the north pole G. aboue A. the north point of our Horizon here at Reading.

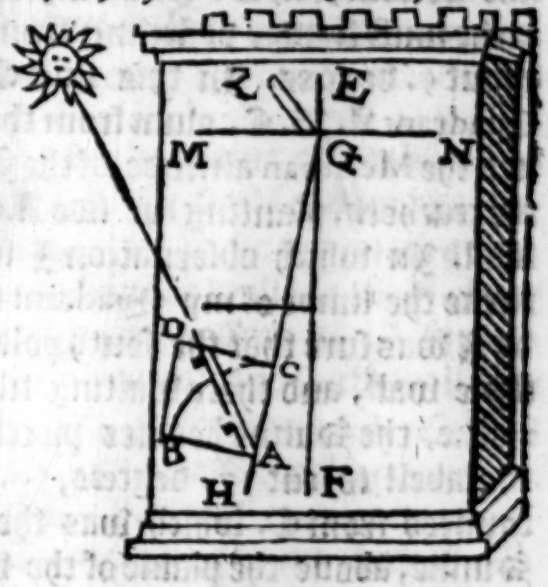


But if on ỳ 12. of December the same were to be done, at which time the Sunnes declination is 23. degrées, 30. minutes southwards, and that day traceth out the parrallell ♈. S. ♍. his declination being then ♍. F. admit his Meridian altitude be then foũd 14. degrées, 55. minutes, so much then must be the Arch ♍. B. In this case now you must adde the Meridian altitude ♍. B. 14. degrées, 55. minutes, to the declination F. B. 23. degrées, 30. minutes, so haue you the Arch ♍. F. 38. degrées, 25. minutes, the height of the Equinoctiall equall to G. C. which taken out of A. C. 90. degrées, leaueth A. G. the poles height 51. degrées, 35. minutes, as before.

Thus you see the reason how to get the poles eleuacion

aboue

aboue your Horizon or any other plaine: yet for reclining and inclining plaines, you may be to seeke, except you know which pole will be eleuated, which to know you shall diligently marke which way you are driuen to turne the limb of your Quadrant, in taking your Meridian altitude: if towards the north, then be sure the south pole is eleuated aboue that plaine, if towards the south, thē the north pole, if this faile you, the 2. Booke, 26. Chapter, will certainely teach you.



Which well obserued, if then by this meanes you first perceiue that the north pole is eleuated aboue your plaine, and would now know how much: then if the Sunnes declination be by the 5. Chapter found north also, you shall take it out of the Meridian altitude, but if south, then adde it thereto, so haue you the Equinoctiall height aboue your plaine, which taken out of 90. degrees, leaueth the eleuation of the pole desired.

But if you perceiue by standing of the Quadrants limbe, as aforesaid, that the south pole is eleuated, you must worke quite contrary viz. to subduct the declination if it be south, and adde it if north. And in countries beyond the Equinoctiall, all these againe are iust contrary: for what is here to bee done for the north pole, must there be done for the south pole, because with them the north pole is vnder the earth.

For example, the 2. of August 1604, being requested to make a dyall on S. Laurence Church steeple wall at Reading. First by the 6. Chapter I drew thereon the verticall

line E. G. F. then by the 11. Chapter, erecting a stile in G. of the line E. G. F. I drew the Meridian of the wall or line of deflexion G. H. being indede the line where the cocke must stand, deflecting from the Verticall line E. F. about 9. degrees. In this line G, H. I then erected my Quadrant A. B. C. plum from the wall, and thereby obserued the Meridian altitude of the Sunne, as the 12. Chapter teacheth, planting the side A. C. of the Quadrant to the wall. In which obseruation I found that I must needes turne the limbe of my Quadrant towards the north: whereby I was sure that the south pole was eleuated aboue the same wall, and there waiting till a little before a 11. of the clocke, the Sunne beames piercing both sights, I found the labell to cut 37. degrees, 30. minutes of the Quadrant, counted from C. which was the Meridian altitude of the Sunne, aboue the plaine of the wall for that day, then by the 5. Chapter I sought the declination of the Sunne, and found it 15. degrees northwards. Now being I was to get the eleuation of the south pole, which I knew as well by turning the Quadrants limbe to the north, as is said, as because it is most certain (with vs on this side the equinoctiall) all plum walles that face or behold the South, haue the south pole eleuated: therefore according to the precept before, I must adde this north declination 15. degrees vnto the Meridian altitude 37. degrees, 30. minutes, thereof commeth 52. degrees, 30. minutes, the true height of the Equinoctiall aboue this wall, which taken out of 90. degrees leaueth 37. degrees, 30. minutes, the true eleuacion of the south pole aboue this wall, and the true height of his dials cocke.

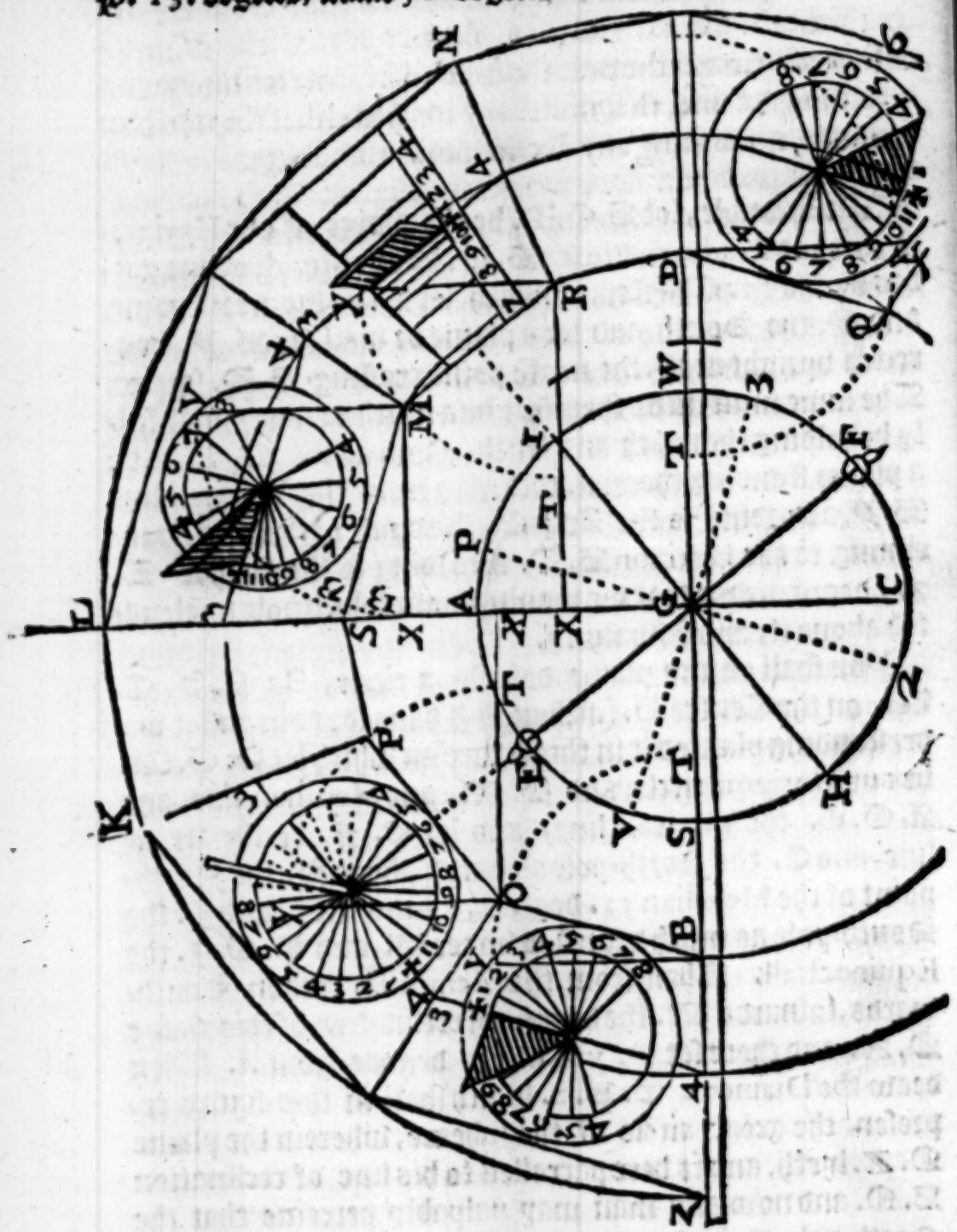
Chap. 14.

How easily to get the poles eleuation of any reclining or inclining plaine, that doth fully behold either the north or south, not hauing any declination.

For example, let B. G. D. be the plaine of our Horizon here at Reading, and let B. D. be our Meridian line gotten by the 11. Chapter, of which let B. be the north point, and D. the South, and let a plaine or wall, as B. Y. be erected vpright at B. the north point, crossing B. D. square. The same must needs therefore be a north or south wall, fully beholding the north and south. Now admit D. Z. to be a plaine standing thereon, reclining from the Verticall line B. Y. according to the Arch D. Y. admit 13. degrees, or inclining to the Horizon B. D. according to the Arch D. T. 77. degrees, and that we would know which pole is eleuated aboue it, and how much.

You shall on any plaine describe a circle, As A. S. C. W. on the Centre G. (although I haue for your easier vnderstanding planted it in this figure) in which let S. G. W. be our Horizon circle, and S. W. our Meridian line, and A. G. C. the Verticall line, and let C. F. be the Artick line, and C. the North-pole eleuated aboue S. the North-point of the Meridian 51. degrees, 35 minutes, and F. the South-pole as much depressed vnder W. and Y. G. I. the Equinoctiall. Then from the Zenith A. reckon Southwards, towards W. the degrees of reclination of this plaine D. Z. and there set Y. viz. at 13. degrees from A. Then draw the Diametre G. Y. 2. which shall in this figure represent the great circle of the spheare, wherein the plaine D. Z. lyeth, and is here parrallell to his line of reclination B. D. and now any man may palpably perceiue that the North-pole C. is eleuated aboue this reclination, Y. 2. so much as the Arch C. Y. commeth to, which is 51. degrees, 20. minutes: for C. A. 38. degrees, 20. minutes, and A.

P. 13. degrées, make 51. degrées 20. minutes.



But now if you desire the poles elevation aboue the vn-

der

der face of the plaine D. Z. represented more plainely in this figure by D. G. you may plainely see that the South-pole F. is eleuated aboue the vnder-side of the line P. 2. which is parrallell to the same inclination, B. D. or D. M. so much as the Arch 2. F. commeth to, which indeede is equal to E. P. before gotten: For in all Horizons or plaines whatsoeuer, loke how much the one pole is eleuated aboue his vpper face: euen iust so much is the other pole depressed vnder it, and eleuated aboue his vnder-face.

Here haue you also in this figure, the plaine M. N. whose line of reclination M. R. is parrallell to the Artick E. G. F. and therefore neither pole can be eleuated aboue it, but must needes be an Equinoctiall or right Horizon.

Then haue you the plaine D. R. whose line of Reclination D. P. lyeth parrallell to the Equinoctiall H. I. and therefore the one pole as E. is Zenith thereto, the other F. Nadir to it: and therefore representeth a polar Horizon.

All other of these reclinations, haue one of the poles still eleuated, as you see the plaine L. M. reclining from the Verticall line M. Y. 78. degrees according to the Arch Y. S. whose line of reclination M. S. lyeth parrallel to G. V: and therefore the North-pole E. is eleuated aboue it, according to the Arch V. E.

Chap. 15.

Of making the Polar Dyall.

This Dyall is commonly called an Equinoctiall Dyall, because the plaine thereof lyeth in the Equinoctiall circle of the spheare, hauing one of the two poles Zenith. But being that the Philosophers, and Cosmographers doe denominate the latitude of any Country by the place of this Zenith, and likewise the Climats and such like: therefore I follow their course in this, as well for that I hold the highest part, the worthiest to denominate, as also for that in my second Booke of Dyalling, the pole Zenith of euery plaine, must

must be all our guide: and therefore I call this Dyall a Polar Dyall, contrary to all other.

Under the pole (but that I hold it is not habitable for cold) this Dyall were an Horizon Dyall, and vnder the Equinoctiall, a North, and South-wall Dyall.

In all Oblique Latitudes, the plaine for this Dyall, except he be wrested from the Meridian, can be no other then such a plaine, as D. R. of the figure of the 14. Chapter, or his vnder-face, because he must behold full the North-pole, or the South, as is said.

This Dyall is no other then a circle diuided into 24. equall parts, by which the 24. hower-lines are drawen from his Center, his cocke is no more but a streight stile or pinne of any length plum-erected in his Center, as the 9. Chapter teacheth, and being planted in any Oblique Latitude, as D. R. the twelue of clocke line, lieth in the line of reclination, 3.4. from which the other howers are easily numbered.

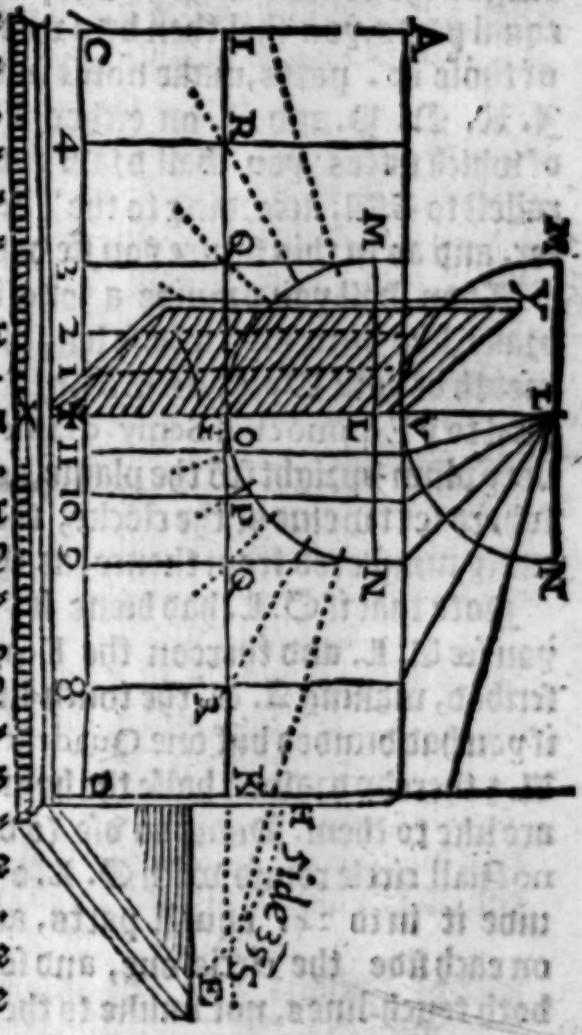
This Dyal, though of all other he be the simplest: yet is he mother to all the rest, as the second Chapter sheweth, and of all other hath beene in most request for Sea-men and trauailers: who haue a deuice with a Quadrant vnder him, to set him fit to euery latitude, and esteeme him as one of their Iewels. But if God permit me, I will shortly fashion them another manner of Equinoctiall Dyall, which shall stand them in farre greater stead then to shew the howre, as in a little pamphlet, which I wrote thereof long sithence, not yet extant, called the Trauellers Tablet, shall appeare.

CHAP. 16.

How to make the Equinoctiall right Horizon Dyall.

THis Dyall, where the Equinoctial is Zenith, is an Horizon Dyall, and vnder either pole, serueth to all their vpright walles: if therefore you should trauell and remaine vnder the Equinoctial, and were to make an Horizon Dyall

all, there in any place round the earth. Admit in such parts of Affrica or America, who haue the Equinoctiall in their Zenith, or else would make a Dial in any other Country or place, to such a plaine as fully beholdeth the South, without declination and yet reclineth from the Zenith Northwards, iustly so much as the complement of the latitude commeth to, like vnto the vpper face of M. N. of the 14. Chapter ẏ working is all one; but ẏif you were, being vnder the Equinoctiall, you must first draw the Meridian, or 12. of clock line, on the plaine of ẏ place, which the 12. Chapter teacheth, which in the said plaine, M. N. the line of reclination 3. 4. alwaies supplieth, because, as is said it beholdeth the full south, without declination.



For example, in our latitude, here at Reading, let A. D. be such a plaine as the plaine M. N. of the 14. Chapter representeth, viz. fully beholding ẏ south, & reclining from ẏ Zenith line, R. Y. iustly so much as ẏ Equinoctials height cõmeth to: which here is 38. degrees, 25. minutes, according to the arch Y. M. of ẏ chapter.

First on this plaine A. D. proposed, draw the Horizontal line C. D. and also the line of reclination E. V. as the seuenth Chapter teacheth: which line E. V. is here the Meridian of

the plaine, wherein the cocke must stand, it is also the Horizontall Meridian, or twelue of clocke line to the Dyall, the reason is, because the Horizontall line C.D. is proposed not to decline. Then draw another line, as I. K. through the middest of your plaine, parrallell to C.D. cutting E. U. at G. which shall be the touch-line to this Dyall. Then set G. L. in G. U. of such distance from G. as you intend your cocks height U. Y. shall be. Then on L. with the space L. G. describe your Equinoctiall Semy-circle Y. G. N. according to the reason of the 3. Chapter, which diuided into 12. equal parts, you shal then by a rule applied frō L. on euery of those 12. parts, make notes in the touth-line, as you see I. K, M. P. and D. on either side of G, through euery of which notes you shall draw your howre-lines, all parrallell to E. U. according to the Theoricke of ỹ third Chapter, and as in this figure you see done.

Then shall you prouide a long square plate of Iron or brasse, like vnto E. Y. whose length E. U. shal be equal to the bredth of your Dyal, viz. C. A. or E. U. & his height U. Y. equal to ỹ Equinoctial Semy-diametre G. L. to be set in E. U. very plum vpright frō the plaine, as the 9. Chapter teacheth, where set twelue of the clocke, the rest of the howers are easily numbered from thence, as this figure sheweth.

Note that if G. L. had bene set without your Dyall, as you see U. L, and thereon the Equinoctiall Y. U. N. described, making A. U. the touch-line, all had bene one: and if you had diuided but one Quadrāt of ỹ Equinoctial, viz. Y. U. & thereby drawen halfe the howre-lines, the other halfe are like to them. Some do vse to describe the whole Equinoctiall circle round with G. L. on the Centre G. and diuide it in to 24. equall parts, and draw two touch lines on each side the circle one, and so the notes being made in both touch-lines, not vnlike to these in A. U. and I. G. the howre-lines are by them the easier made parrallell.

CHAP. 17.

Chap. 17.

How in any Oblique latitude to make an Horizon dyall, or any Oblique dyall to any wall or plaine, that declineth not from the north or south.

Very vnaduisedly do other Authors terme an Oblique dyall to be an Horizō dyall, for vnder the pole, the Polare dyall is an Horizon dyall, and vnder the Equinoctiall an Equinoctiall dyall, as is said, but true it is to all places not being directly vnder one of the poles, or vnder the Equinoctiall, the Horizon dyall falleth out to be an Oblique dyall, as the 1. Chapter manifesteth.

When as therefore you are to make an Oblique dyall to any Horizon in these parts of the world, or else to any other reclining plaine that beholdeth the full south, and declineth not in any Horizon, such as the plaines D. Z. and L. Y. of the 14. Chapter doe represent: if it be for the Horizontall plaine of any place, admit the plaine of our Horizon here at Reading, you shall first draw thereon the Meridian line A. C, by the 11. Chapter, which labour you may saue in plaines reclining, that decline not: for the line of Reclination 3.4. in those reclining plaines is the Meridian ready drawne. Secondly you must by the 13. or 14. Chapter get the poles eleuation aboue the Horizon or plaine.

These be the two first points in all dyals, which had then on some point of the Meridian line A. C. viz. T. describe a circle for your dyal, as A. X. E. W, then draw the Diametre or east line X. T. W. crossing square the Meridian A. T. E. on the centre T. so shall T. E. in all these dyals that decline not, be the 12. of clocke or none line, and T. W. for 6. of clocke at noone, and T. X. for 6. at night.

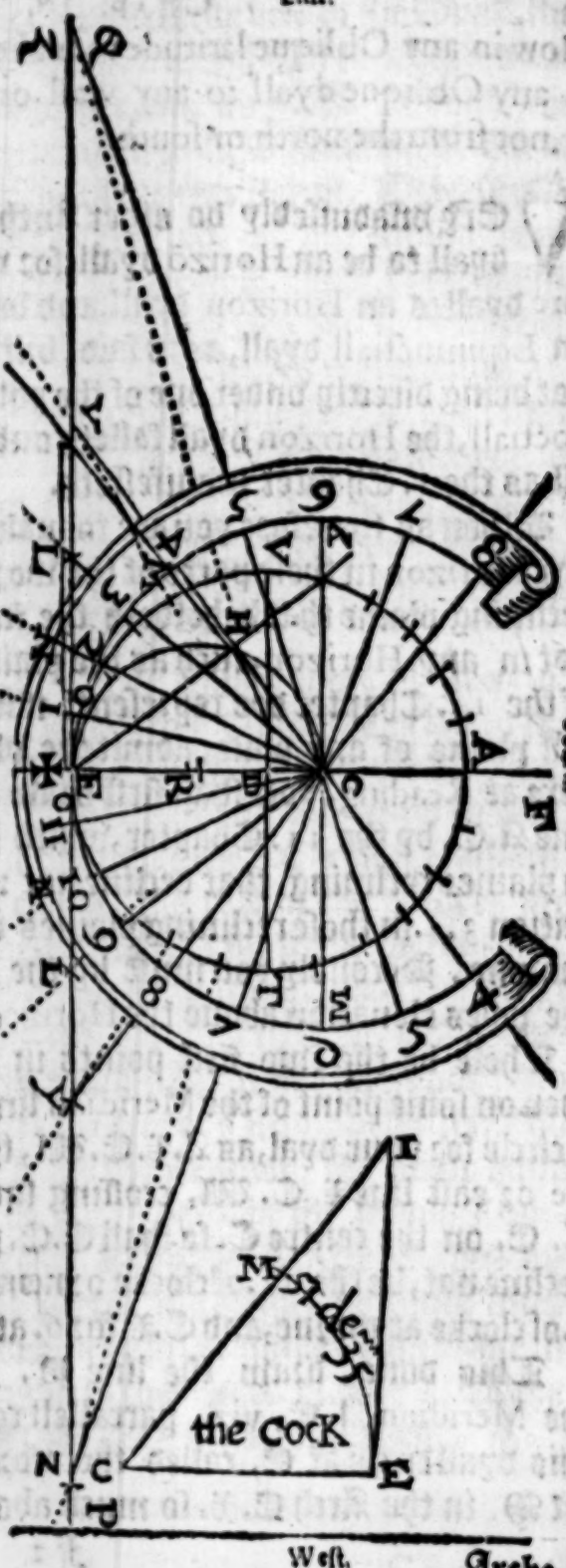
This done, draw the line Y. D. crossing square the Meridian A. E, viz. parrallell to X. W. and touching this dyall circle at E, called therefore the touchline, then set Y. in the Arch E. X. so much aboue E. as the eleuati-

on of the pole commeth to, viz. 51. degrées 35. minutes for vs here at Reading, the extend the line C. Y. to crosse the touchline P. N. at I. So is C E. I: or if you will C. E. Y. the true patterne for the cocke of this dyall.

Then on the middest of C. E. viz. on R. with the quantity R. E. or R. C. describe a blinde semicircle E. Y. C. cutting C. I. at Y. and drawe ỹ line E. Y. which shall be euer a perpendiculer to C. I.

An Oblique horizontall Dyall, where the North pole is eleuated 51. degrees 35. minutes.

And now if you mark well this figure, the two tryangles I. E. C. and E. Y. C. are no other but the selfe same tryangles represented in the figure of the 2. Chapter, E. C. beeing here the semydiameter of the Horizontal dyall, and E. Y. of the Equinoctiall dyall, that must project his howre-lines: wherefore open your compasse from E. till it become *breuissima extensa* to C. I, that is, till it doe onely touch C. I. at Y. and therewith on E. describe a blinde



Arch, as Y. D. cutting E. T. at D whereby E Y is let downe to E D the plaine of the Horizon, as in the end of the 2. Chapter was noted.

Describe therefore on D the Equinoctiall semycircle W. E T A. touching also the touchline P. M. at E, and drawe his dyameter W D. T. parrallell to ✠ C W. then deuide his Quadrants E. W. and E. T. each into six equall parts, and by a rule laid on euery of them, from D. direct blinde lines, as you see D. D. D N D L D. Y. and D. Z. on both sides of E. crossing the touchline P. M. at D. and N. and L. and Y. and Z. Lastly a rule laid from C. the centre of your dyall on euery of those points of crossing, you shall thereby strike out the howre lines desired for your dyall, seruing from 6. at morne, to 6. at night, viz. C. D. C. N. C. L. C Y. and C. Z. on each side of C. E. vnto which you may easily set numbers, as in this figure you see done

Then for the howre-lines before 6. in the morning, & after 6. at euen, they are easily drawne, onely by extending ỳ former howre-lines, throw the center C. vnto the Dyals other semycircle ✠. F. W. But with vs wee neede but 4. of them, viz for 4. and 5. in the morne, and 7. and 8. at Euen, as here you see, the rest are houres of the night, and therefore left quite out in our Horizon Dyals.

But for all these kinde of Oblique dyals that decline not, you might by one quarter of the Equinoctiall, viz. E. T. deuided into 6. equall parts haue furnished one quarter of your dyall circle, viz E. W. with houre-lines, and then vp a paire of compasse, the one foote planted in E the other extended to the howres in the Quadrant E. W. you might haue transferred them into the Quadrant E. ✠. ye and from F. the same scantlets serue to the Quadrants A. ✠. and. A. W. also; For euer by one quarter of these, the whole may be described.

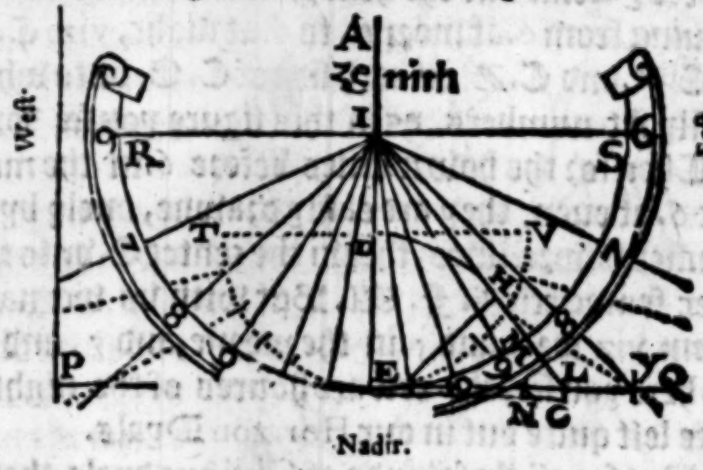
Lastly, bring that I. E. C. is the true patterne of this dyals cocke, let him be made in mettall and planted plum vpright in the Meridian, as here you see.

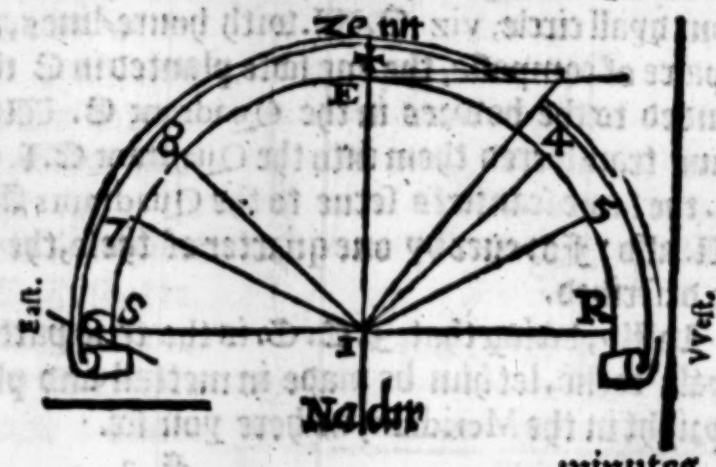
Note that if you diuide the parts of the Equinoctiall M. E. T. each into halfe, or into foure parts, and extend lines from D. through those parts to crosse the touch-line P. D. so may you by lines extended from C. to those crossings, diuide each howre into halfe howres or quarters.

CHAP. 18.

How to make the North, and South-wall Dyals, in euery Oblique Horizon or Latitude.

THe making of the South and North-wall-Dyals, in any Oblique latitude, differ in manner nothing from the making of the Horizon Dyal: and in some respects, they are a litt'e easier, because the two principall things are euer giuen and had without labour, viz. the Meridian or 12. of clocke line: and the poles eleuation the Meridian line, in these is all one, with ỹ Verticall line, and the poles eleuation is alwaies equall to the complement of the latitude, that is to say, to so many degrées as ỹ latitude lacketh of 90. degrées, being with vs 38. degrées, 25. minutes.





minutes. Also ẏ Dials to all such reclining plaines, as L. Y. Y. 6. or D. Z. of the 14. Chapter, w̄ do not decline differ as little: for in them the line of reclination 3. 4. serueth both for the Meridian and 12. of clocke line: as for their Elevations, it is there plainely shewed how easily to get them.

When as therefore you shall come to a wall that fully beholdeth the South, which you may easily know any day, iust at 12. of clocke: for then a stile erected thereon, shall cast his shade euen on the plumme-line, which knowen, first draw thereon the Verticall or plumme-line A. C, as the fifth Chapter teacheth, and also the Horizontall line R. I. S. crossing A. C. square at I. the one of these, viz. A. C. shall be your Meridian and 12. of clocks line: the other R. S. your East, and 6. of clocke line. then on I. describe the Semy-circle for your Dyall R. C. S. cutting R. I. S. at R. and S. for no plumme erected wall or plaine can shew aboue 12. howers. Then through C. draw the touch-line Y. C. M. parrallel through ẏ East line S. I. R, then set Y. in C. S. so farre frō C. as the poles elevation cōmeth to, w̄ with vs, must be 38. degrees 25. min. for so much is the complement of our latitude, being here, viz. 51 degrees, 35. minutes. Then extend the line I. Y, till it crosse the touch-line Y. M. at C, so haue you the try-angle, I. C. C. like to I. C. C. of the second Chapter, being the true cock of these Dyals, and must be planted in I. C, as here you see. Then extend your compasse from C. till it touch I. C. at Y. and with that width, cut off C. I. at D: for indeed the Semy-circle C. Y. C in the last chapter, was superfluous, but only to draw C. Y for demōstration sake only. Then on D. with ẏ quantity D. C. describe the Equinoctial Semy-circle T. C. V. & crosse it square to D C, with the Dyametre T. D. V, and then in all other things proceed, as the last Chapter teacheth, and as this first figure sheweth.

I said before that no plumme-wall, can receiue the sunne aboue 12. howers, but the North, & north declining walles, cannot receiue so many, because the 12, of clocke in them

is

is 12. at midnight: and therefore the North-wall Dyall hath but foure, and fiue, and six of clock in the morning, & six, seuen and eight of clocke howre-lines at night, as this second figure sheweth. The making of the Dyall is all one with the South-dyall, and the very same: but that in this the cocke and 12. of clock, is turned vp to the Zenith, whereas in the South-dyall, it pointed to the Nadir, the patterne of the South-dyall made in paper, applyed to the North-wall, and turned topsie turuy, and the howres altered will serue this turne.

CHAP. 19.

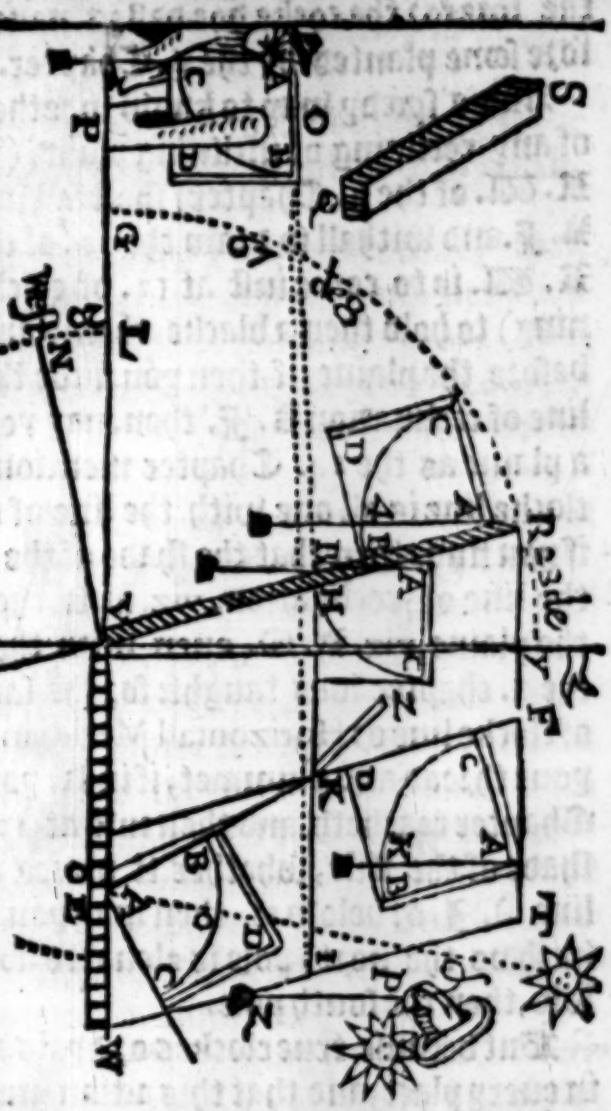
How in any Oblique latitude to plant the twelue of clocke howre-line, on any vpright wall declining, or on any reclining or inclining plaine, or declining walles.

I shewed in the first chapter, what the Meridian circles of the Spheare are, so called of the word Meridies, in English Noone, because it is neuer none or twelue of clocke in any country, till the Sunne come to the Meridian circle of that place, that is to say, directly euen with the Meridian line of the same place. I shewed also that euery wall or plaine howsoeuer scytuate, lyeth in some ons Horizon or other of the world.

Now know that euery Horizon or plaine, lying Eastwards, or West-wards, from the North or South, hath his proper Meridian: and it appeareth by the 14. 17. and 18. Chapter, that in euery latitude, the North and South walles, and such plaines as do recline or bend backe, directly North or South, haue one & the selfe same Meridian & twelue of clocke line, direct with the Meridian of the place whereon they are set, being the plum-line in the one, and the line of reclination in the other.

But now you shall vnderstand that all other walles or plaines

plaines, that wrye Eastwards or westwards from the Meridian of ỳ place, the proper Meridians, that is to say, their lines wherein ỳ cocke must stand, doe also wry away with thē, whereby that line which in euery such Horizon, represented by such wall or plaine, should be the twelue of clocke line, must nedes differ so much from the 12. of clocke line of your place, as their Meridians are wryed one from another. So ỳ the line of ths cocke is one line, and the twelue of clocke line another. Which two in his own proper Horizon, would otherwise be all one line.



It hath already beene manifested that in all reclining and inclining plaines, that doe fully behold the north or south, such as the 14. Chapter treateth of, their 12. of clocke line, & the line for the cocke, fall both in the line of reclination: but now wee shall shew how in all other reclining or inclining plaines that wry aside eastwards or westwards, their 12. of clocke line, and their line for the cocke doe both decline or deflect one from another, and both from the line of reclination: but in all vpright walles, the east and west excepted, the 12. of clocke line still keepeth the Verticall line, although

the line for the cocke do: deflect neuer so much: and therefore sone planted by the 6. Chapter.

And a spedy way to know whether the 12. of clocke line of any reclining or inclining plaine (as admit of the plaine R. W. of the 7. Chapter) shall fall in his line of reclination R. F. and withall to draw the 12. of clocke line on the plaine R. W. is to come iust at 12. of clocke, and (the sunne shining) to hold then a blacke thread and plummet, as P. Z. before the plaine, if then you finde the shade to fall iust in ỹ line of reclination R. F. then may you be sure that it is such a plaine as the 14. Chapter mentioneth, viz. that the 12. of clocke line is all one with the line of reclination R. F. But if you finde then that the shade of the thred will nods crosse the line of reclination, viz. at R. then marke out a line on the plaine, viz. R. D. euen with the shade in maner as in the 6. chapter was taught: for the same line shall be the 12. of clocke line or Horizontall Meridian desired, but in stead of your thread and plummet, if in R. you erect a stile as the 9. Chapter teacheth, and then iust at 12. of clocke marke the shade of the stile, whether it project aboue the Horizontall line H. I. or below it, then may you be sure, if aboue, that with vs the northpole is elouated aboue that plaine, if below, then the south pole.

But because true clockes or dyals are not alwaies ready in euery place, and that this action must be done iustly at 12 of clocke, not to misse a minute, if it might be: therefore a surer way is to strike out a Meridian line on some stoole or other plaine lying leuel with your Horizon, and therein erect a stile of a good length, as the 9. chapter teacheth, then any day at what time you finde the shade of the stile to fall iustly in that Meridian line, you may be sure it is then iust 12. of clocke, and a fit time for your purpose aforesaid.

CHAP. 20.

Chap. 20.

How in any Oblique latitude to make a dyal to any vpright wall that wryeth or decline̅th from the full south or north.

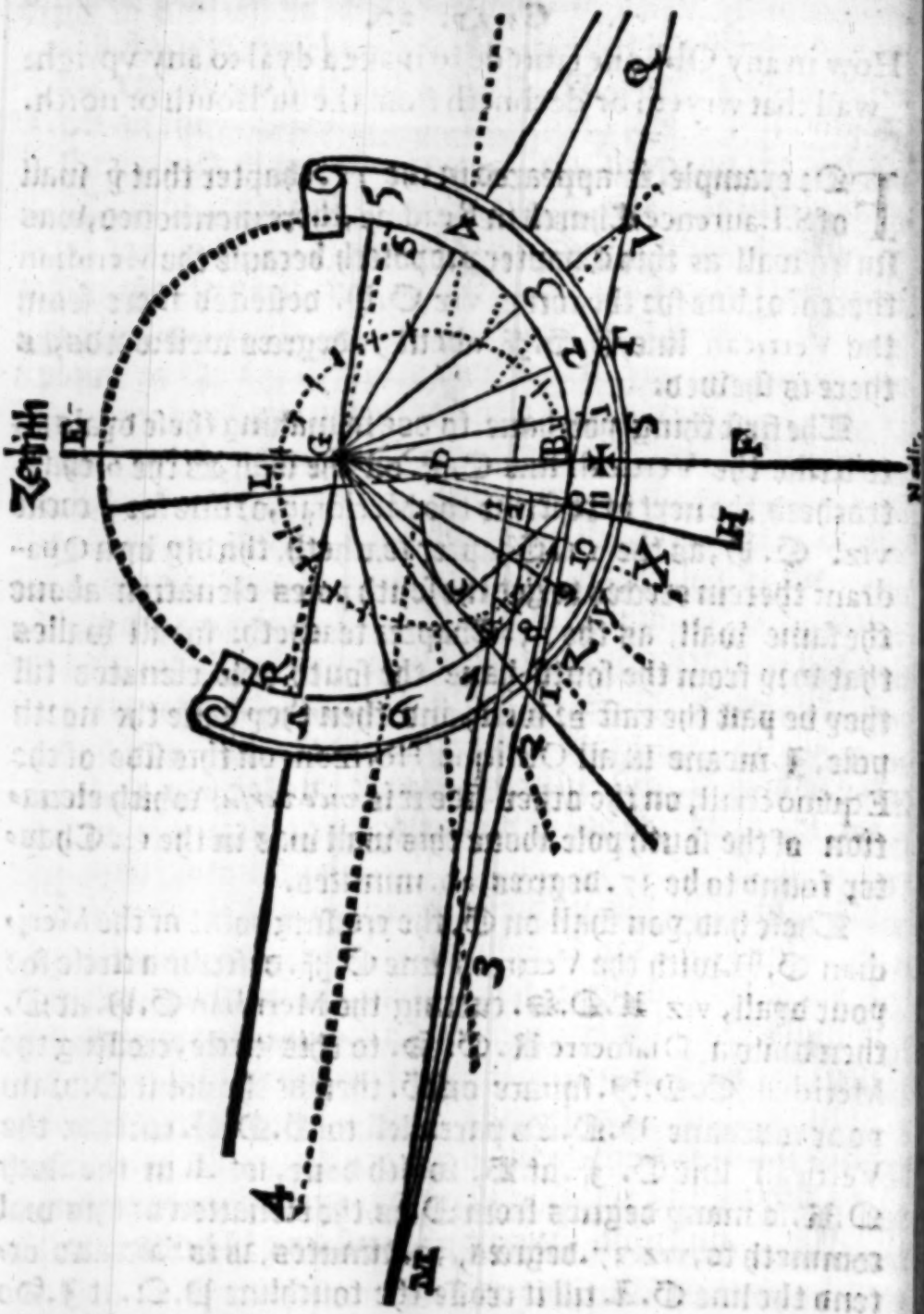
For example, it appeared in the 17. chapter that ỳ wall of S. Laurence Church in Reading, there mentioned, was such a wall as this Chapter proposeth, because the Meridian thereof or line for the cocke, viz. G.Y. deflected there from the Verticall line, E.G.F. about 7. degrees westwards, as there is shewed.

The first thing you haue to doe in making these dyals is to strike the Verticall line E.F. on the wall, as the 6. chap. teacheth, the next is to strike the Meridian, or line for ỳ cocke viz. G.Y, as the 11. Chapter teacheth. thirdly by a Quadrant therein erected to get the south poles eleuation aboue the same wall, as the 13. Chapter teacheth: for all walles that wry from the south, haue the south pole eleuated till they be past the east or west, and then they haue the north pole, I meane in all Oblique Horizons on this side of the Equinoctiall, on the other side it is *vice versa*. which eleuation of the south pole aboue this wall was in the 13. Chapter found to be 37. degrees, 30. minutes.

These had, you shall on G, the crossing point of the Meridian G.Y. with the Verticall line G.F. describe a circle for your dyall, viz. R.D.S. cutting the Meridian G.Y. at D. then draw a Diametre R.G.S. to this circle, crossing the Meridian G.D.Y. square on G. then at the point D. draw your touchline P.D.N. parrallell to G.D.Y. cutting the Verticall line G.F. at B, which done, set A. in the Arch D.R. so many degrees from D. as the eleuation of this wal commeth to, viz. 37. degrees, 30. minutes, as is said. and extend the line G.A. till it crosse the touchline P.D. at I. So is G.D.I. the true patterne for the cocke of this dyall. The from D. extend your compasse till it touch G.A. at C, and with ỳ widthe D.C. cut off D.G. at D, then on D. with D.

D. describe your Equinoctiall circle L. D.

A Dyall declining from the South eastwards, 11 degrees, angle of deflection 9. degrees, cockes eleuatiõ 37. degrees 30. min.



Hitherto we differ very little from the 17. and 18. Chapters, but now because the houres of any dyall must bee all num-

numbred from the 12. of clocke line, which in all vpright walles is the Verticall line, as is said, all the skill of these declining dyals is to know from what point of this Equinoctiall circle L.D, you shall begin to deuide him into his 24. equall parts: For whereas in dials that decline not, you must begin from the point where the Meridian & touchline doe crosse, as by the 17. and 18. chapters you may perceiue. Now in these dyals that wry aside and decline, you must begin from the point where the touchline P.M. and 12. of clocke line G.F. doe crosse, viz. B, which knowne, all the rest is as easily done as the 17. and 18. chapters are, and by the selfe same reason.

Wherefore you must now lay a rule on D. and B. & thereby draw a Diametre L.D.B. to your Equinoctiall, then deuide each halfe of your Equinoctiall circle L.D. on each side of L.D. M. into 12. equall parts, which make in the whole 24. All which done, laying a rule on each of those 24. parts of your Equinoctiall from his Centre D, or at least on so many of them as will fit, you shall thereby crosse or make notes in the touchline, viz. S.T.V. &c. on the east side of B. and X.Y.Z. 2.3. and 4. on the west side: Lastly laying a rule from the dyals centre G. on euery of those notes in ỹ touchline, you shall thereby draw all the howre lines of your dyall, and number them from the 12 of clocke line G.B. in order, as in this figure you see done, and whereas the line D. 4. will run from ỹ Equinoctiall centre D. a very great way before he crosse the touchline, by which crossing the howre line G.5. should be drawne on your dyall, you shall set D. 2. in D.D. either halfe a third or a quarter of D. D. also set D.1. in D.G. accordingly either halfe a third, or a quarter of D.G, both which in this figure I haue set at ỹ quarter of each, because that fitteth best, then extend 2.Y, parrallell to D.4. till it crosse the touchline P.M. at Y. then extend 1.Y. Lastly you shall draw your howre line G.5. parrallell to 1.Y. so is G.5. truely placed, though D. 4. be not extended.

When all is done, you shall make your cocke in mettall, equall to G.D.I, and plant him very vpright and plumme from the wall in the Meridian G.D. as the 9. Chapter teacheth.

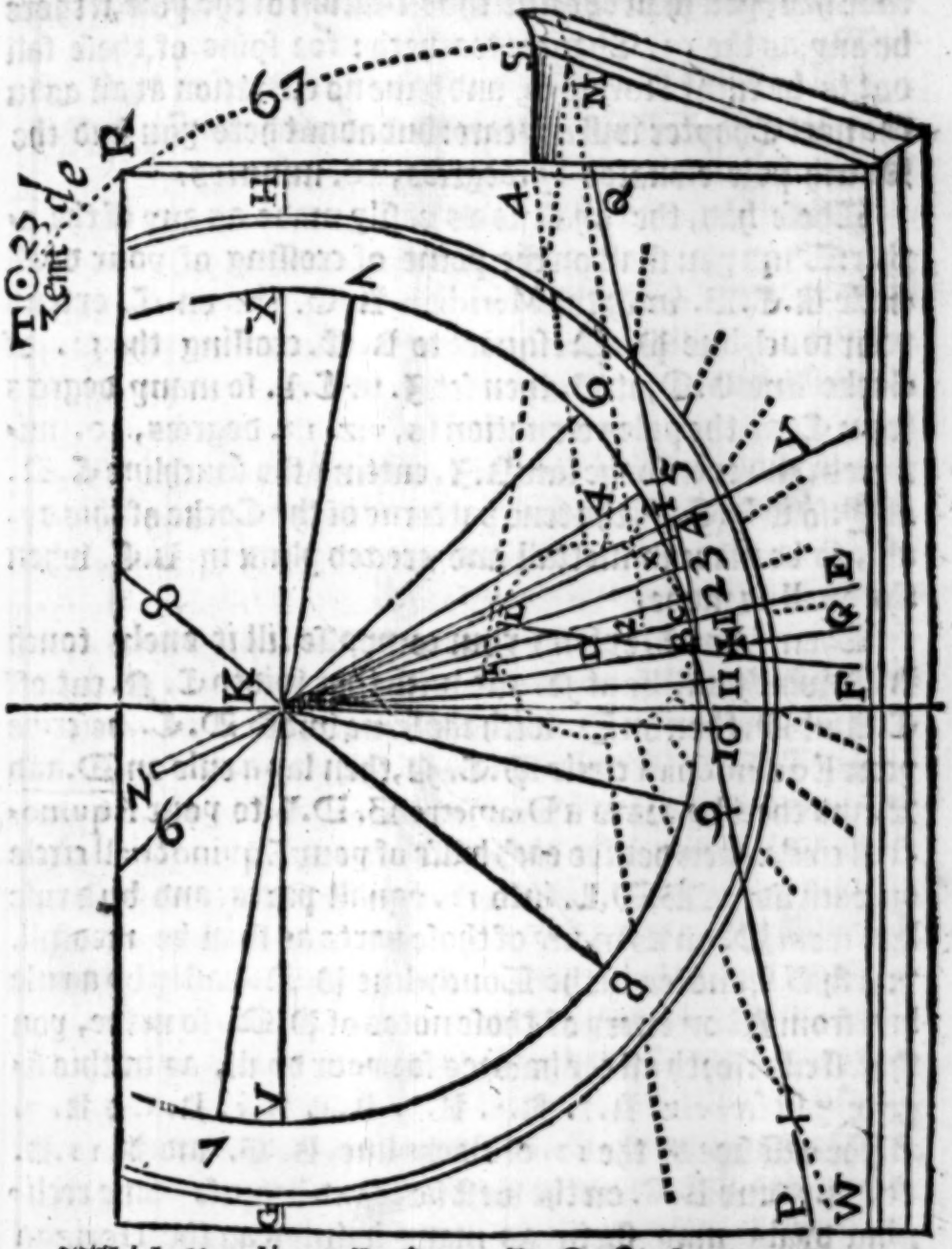
Note that if you desire more houres in your dyall, you may draw forth any of these beyond G. to the semycircle K.E. but on vpright walles, these will suffice.

Chap. 21.

How in any Oblique latitude to make a dyall to any reclining or inclining plaine, that wryeth or declineth from the north or south.

IT is shewed in the 19. Chapter, that of all reclining and inclining plaines that way aside from the north or south, their Meridian and 12. of clocke line doe deflect each from other, and both from the line of reclination: when as therefore you are to make a dyall to any reclining or inclining plaine whatsoeuer, admit the plaine K.M. of the 7. Chap. reclining northward 23. degrees, and declining 20. degrees westwards. First you shall draw thereon the Horizontall line G.H. & the line of reclination K.F. as there is taught, although we haue here no nede to vse either of them. Then on some point thereof, admit K. describe your dyall circle, M.C.X. and in K. erect a stile or pin K.Z. very plum, as the 9. Chapter teacheth, by which you shall get the Meridian of this plaine or place for the cocke, viz. K.C. as the 11. chap. teacheth, which Meridian K.C. you shall according to the note in the end of the 11. Chapter finde to extend vnder ỹ Horizontall line G.H: and therefore be sure that ỹ south pole is eleuated aboue this plaine, which done, then iust at 12. of clocke, holding a thread and plummet betweene the Sunne and this plaine, you shall moue it to and fro, till the shade crosse at the point K, and thereby draw the 12. of clocke line K.D as the 19. chapter teacheth, vnder the Horizontall line G.H: also for the Meridian line of the plaine, and this

this must fal both one way, and the angle D. K. E. included by them, is in the 2. Booke called the angle of deflection.



Which two lines, K. E. and K. D. so planted, then erecting a Quadrant in the Meridian K. E. you shall, as the 12. Chap. teacheth, get the Meridian altitude of the Sun, where you shall also finde the ring of the Quadrant turned to

to the North, which argueth the South pole to be eleuated, as in the 13. Chapter was noted, by which Meridian altitude had, you shall obtaine the eleuacion of the pole, if there be any, as the 13. Chapter teacheth: for some of these fall out to be right Horizons, and haue no eleuacion at all as in the next Chapter will appeare: but admit here you find the South pole eleuated 13. degrées, 30. minutes.

These had, the dyall is as easily made as any of the other: Thus you shall on the point of crossing of your dyall circle H.C.B. with the Meridian K.E. viz. on C. extend your touch line P.M. square to K.E. crossing the 12. of clocke line K.D, at B. then set I. in C.E. so many degrées from C. as the poles eleuation is, viz. 13. degrées, 30. minutes, and extend the line K.I. cutting the touchline C.M. at Y. so is K.C.Y. the true patterne of the Cocke of this dyall, to be made in mettall and erected plum in K.C. when the dyall is made.

Then from C. extend your compasse till it onely touch K.I. which will be at N. and with that width C.N. cut off C.K. at D. then on D. with the same width D.C. describe your Equinoctiall circle N.C.N, then lay a rule on D. and B. and thereby draw a Diametre B.D.L. to your Equinoctial circle, then deuide each halfe of your Equinoctiall circle on each side of B.D.L. into 12. equall parts, and by a rule laid from D. on as many of those parts as shall be needfull, you shall set notes in the Touch-line P.M. Lastly by a rule laid from K. by euery of those notes of P.M. so made, you shall strike forth all the howres for your dyall, as in this figure you see, viz. K.1. K.2. K.3. K.4. K.5. K.6. & K.7. on the east side of the 12. of clocke line, K.B. and K.11. K.10. K.9. and K.8. on the west side: and because some reclining dyals may shew as many howres as the Horizon dyall: therefore I haue drawen forth the howre-lines 7. K. 6. K. and 8. K. for 8. of clocke at night, and 6. 7. in the morning.

Chap. 22.

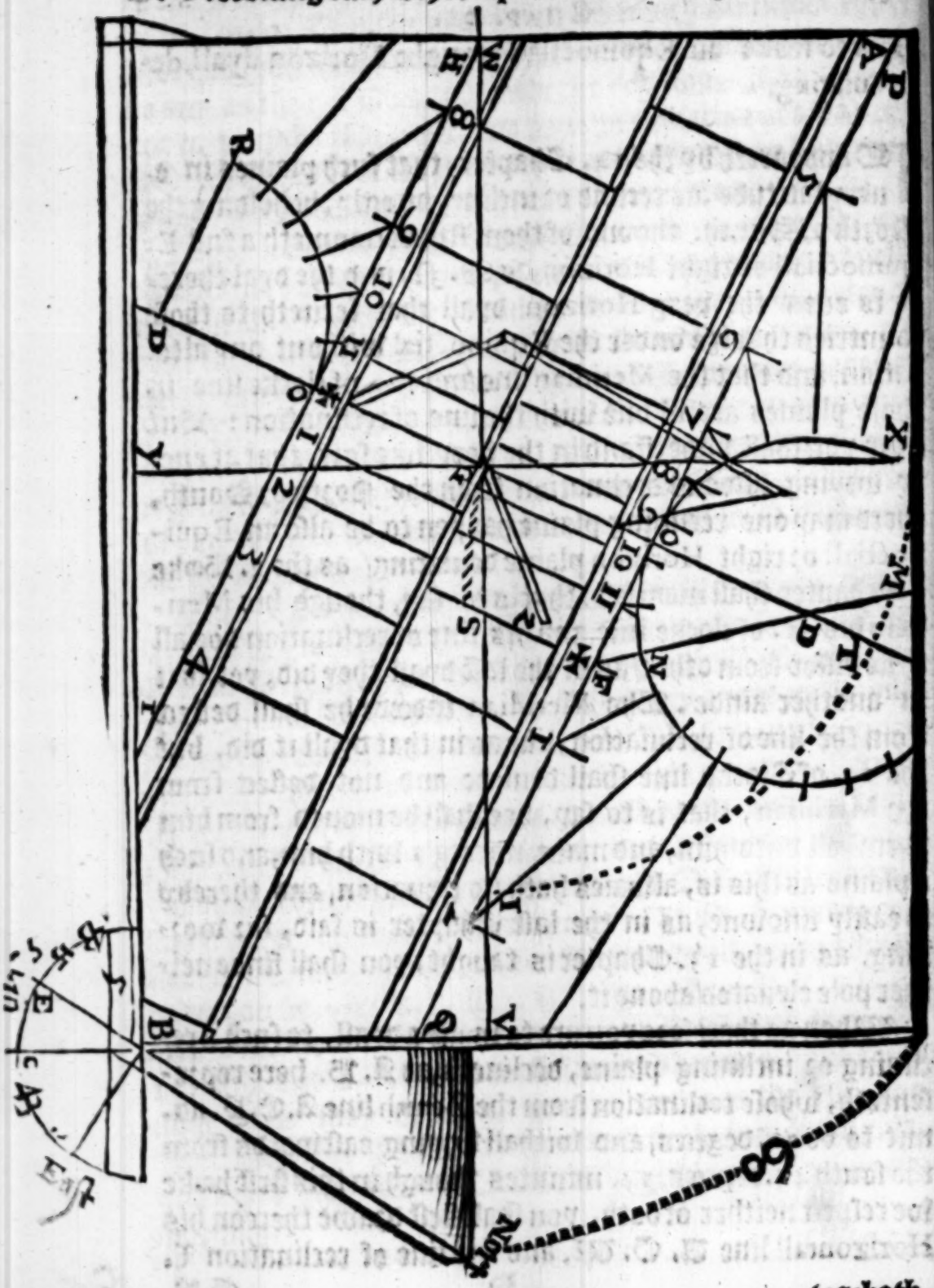
Chap. 22.

How to make an Equinoctiall or right Horizon dyall, deuiating.

It appeareth by the 14. Chapter, that such plaines in euery latitude, as recline or incline, directly, beholding the North or South, the one of them still becommeth a full Equinoctiall or right Horizon, as P. N, and the dyal thereto is euen the very Horizon dyall that serueth to those countries that lye vnder the Equinoctial without any alteration, and that the Meridian line and 12. of clocke line in those plaines are all one with the line of reclination: But now you shall vnderstand in the very like sort, that at euery wrying aside or declination from the North or South, there may one reclining plaine happen to be also an Equinoctiall or right Horizon plaine deuiating (as the 2. Booke 26. chapter shall manifest) that is to say, though his Meridian his 12. of clocke line, and his line of reclination doe all three differ from other, as in the last dyall they did, yet is it in another kinde. The Meridian indeede he shall deflect from the line of reclination, like as in that dyall it did, but the 12. of Clocke line shall deuiate and not deflect from the Meridian, that is to say, hee shall be moued from him parrallell vnto him, and make no angle with him, and such a plaine as this is, alwaies hath no elevacion, and thereby is easily knowne, as in the last Chapter is said, for working, as in the 13. Chapter is taught, you shall finde neither pole eleuated aboue it.

When as therefore you are to make a dyall, to such a reclining or inclining plaine, declineth, as A. B. here representeth, whose reclination from the Zenith line A. C. Y. admit to be 30. degrees, and withall wrying eastwards from the south 43. degrees, 15. minutes, though in this first booke we respect neither of both, you shall first drawe thereon his Horizontall line V. G. W. and his line of reclination X.

G. W. crossing each other square at G, as the first Chapter



teacheth.

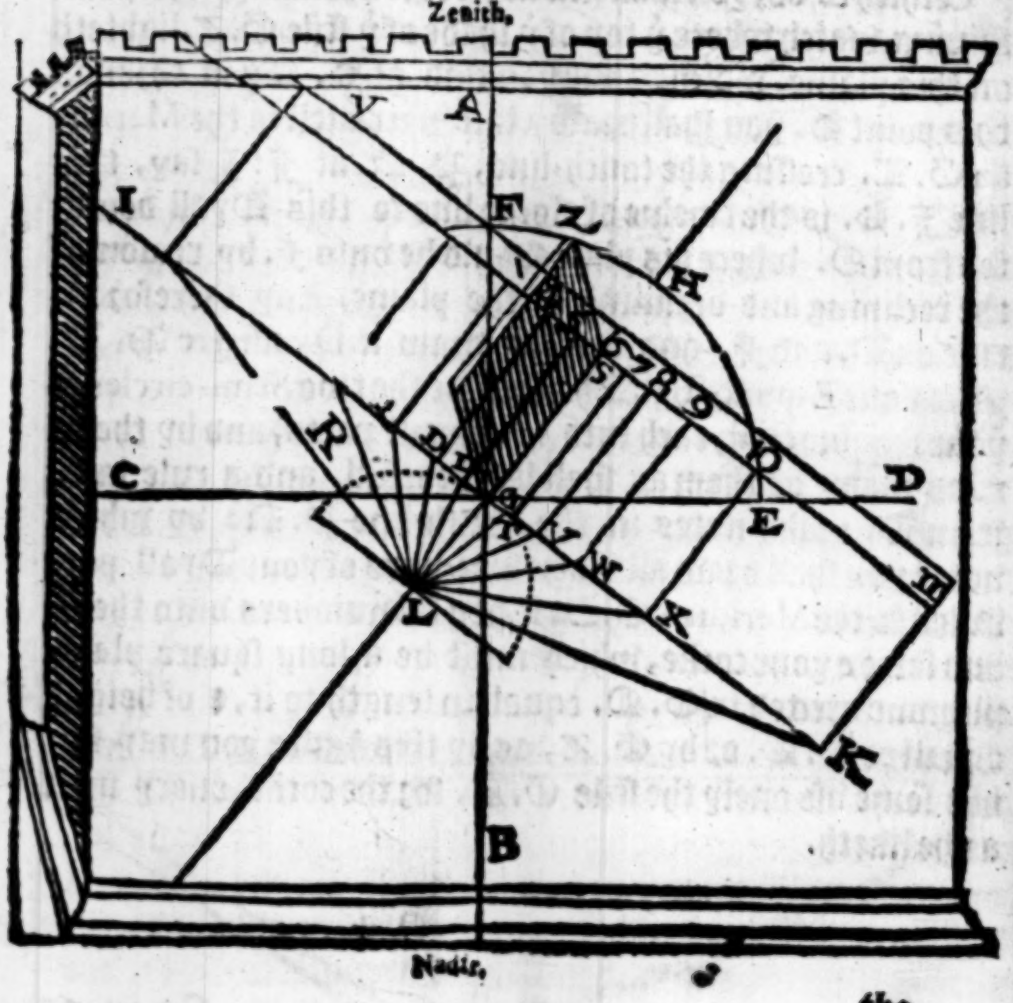
teacheth. Then by the ninth chapter, erect on G. a stile or wyer, very plumme vpright, iust of that length as you intend the height of your Dyals cocke to be, viz. G. Z. by helpe of which, you shal draw the Meridian of the plaine G. T, as the 11. Chapter teacheth: And hitherto we differ not from the last Chapter. Then set D. D. in G. T. equall to G. Z. and through D. extend a line, P. D. N. crossing the Meridian, G. D. T. square on D, which line P. N. shall be your touch-line. Then on D. with D. D. describe your Equinoctiall circle, P. D. N, touching the line P. N. at D. Now all the skill is to know where to begin to diuide P. D. N. into his 24. equall parts.

Which to do, you shall iust at twelue of clocke, the Sun shining, watch where ẏ top of ẏ shade of ẏ stile G. Z. lighteth on this plaine, which admit you find at S. Then through this point S. you shall draw a line parrallell to the Meridian G. T. crossing the touch-line, P. N. at F: I say, this line F. S. is the twelue of clocke line to this Dyall deuiated from D. where his place should be vnto F. by reason of the reclining and declining of the plaine. Lay therefore a rule on D. and F. and thereby draw a Dyametre P. D. N. to your Equinoctial. Then diuide the two Semi-circles of your Equinoctial, each into 12. equall parts, and by them, or as many of them as shall be needefull, and a rule laide from D. make notes in the touch-line P. N. by which notes you shall draw all the hower-lines of your Dyall parrallell to the Meridian G. D. Then set numbers vnto them, and set on your cocke, which must be a long square plate, plumme erected in G. D. equall in length to it, & of height equall to D. D. or by G. Z, as by this figure you may see, but some vse onely the stile G. Z. for the cocke, euery man as he liketh.

CHAP. 23.

How to make the East and West wall Dyals in any Oblique Horizon or Latitude.

IN all Oblique Latitudes, the Dyall to the East, & West walles, are no other but the Equinoctiall or right Horizon Dyall, deuiating iust 90. degrées, which amounteth to iust fiue howers: and therefore the cocke alwaies standeth fiue howers from the twelue of clocke line, which being a thing so certaine, they are in euery Latiude more easily to be made then any other deuiating right Horizon Dyall: for being the deuiation is alwaies 90. degrées giuen, and that

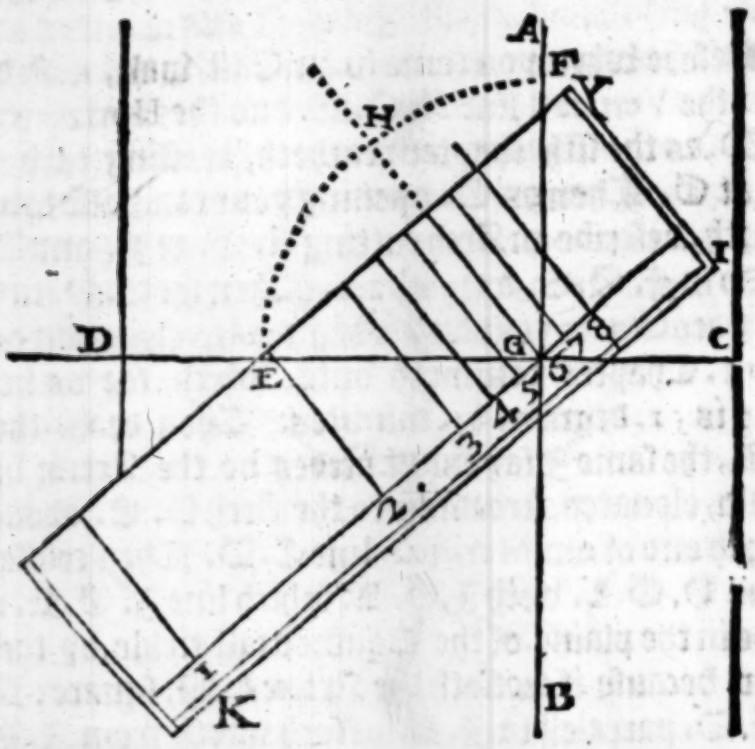


the

the plaine of these two walles, do in euery Latitude lye in the plaine of the Meridian circle of the Horizon: therefore euery line drawen thereon is a Meridian, but the Horizontall line it selfe is indéede both the Horizontal Meridian, and the Meridian of the wall, and aboue that line, the Axtrée line must of necessity be eleuated so much as the Latitude of the place commeth to, which with vs is 51. degrées, 35. minutes.

Therefore when you come to an East wall, first drawe thereon the Verticall line A. G. B. and the Horizontal line C. G. D, as the 5th chapter teacheth, crossing each other square at G. Then on G. opening your compasse towards the North, describe an Arch cutting A. G. at F. and D. G. at E. So is F. G. E. a Quadrant. Then set E. H. in E. F. so many degrées as your Latitude, or poles eleuation gotten by the 13. Chapter commeth vnto, which for vs here at Reading is 51. degrées, 35. minutes: Then draw the line H. G. L, the same I say, must néedes be the Axtrée line of the world, eleuated according to the Arch H. E. aboue D. the North end of our Meridian line C. D. Then crosse that Meridian H. G. L. with I. G. K. which line I. G. K. must néeds lye in the plaine of the Equinoctiall cirkle, by the first Chapter, because it crosseth the Axtrée L. H. square: Then draw P. D. parralell to I. K. of such width from I. K. as you meane your diall shall be of: Then set L. in H. G. L. as farre from G. as you meane the height of your dials cocke G. Z. shall be, and thereon describe your Equinoctiall semicirkle H. G. N, according to the reason of the third Chapter, vnto which cirkle I. G. K. shall be the touch-line. Then draw the diametre H. L. N. parralell to I. G. K, and deuide H. G. N. into twelue equall parts, through euery of which twelue parts, from L. extend lines to crosse the touch-line I. G. K, as you sée L. I, and L. K, and L. M, and L. H, and L. D. &c. Lastly by euery of those crossings P. D. G. T. V. W. X. and K. draw lines parrallel to G. H, but all comprehended or cut off by I. K. and P. D. and those

ſhall be the howꝛe-lines of this diall, of which the axtrée line G.S. wherein the cocke G.Z. muſt ſtand, ſhall be 6. of clocke in the moꝛning, by which you may eaſily number the other howers, as here you ſée. The cocke muſt be a long ſquare plate, erected in G.S. in length equall to G.S, and in height equall to G.L.



Note that a quadꝛant of the Equinoctiall, viz. G.N. might haue ſufficed to make this diall, by tranſferring the notes G.O. and G.P. equall to G.T. and G.V: foꝛ thoſe two ſerue foꝛ 4. and 5. of clocke in the moꝛning, the reſt of that ſide are ſuperfluous in our country, becauſe the Sunne neuer riſeth with vs much befoꝛe 4. of clocke.

Behold here alſo the Weſt wall diall naked made in all reſpects, like the other *vice verſa*, in ſo much that the backe ſide of the patterne of the Eaſt diall befoꝛe made in paper ſerueth the Weſt wall beeing applied thereto, ſo that the Verticall line A.G.B. hang perpendicular oꝛ euen with a plumme line, but that you muſt change the numbers ſet

to

to the hower-lines: for here the cocke standeth at fire at night, and neither of these two dials can haue 12. of clocke, because then the shade of the cocke becommeth infinit parralell to the wall, and vanisheth away.

Chap. 24.

Of making Dials to all North declining plaines, as well vpright as reclining or incliming.

In all North declining plaines, you can neuer in many of them take the Meridian altitude of the Sunne, as the 13. Chapter teacheth: because the Sunne commeth not about to their Meridian. And in some of them also that incline towards the South, the Sunne being in the Meridian, either appeareth not to them at all, hauing but onely two or three howers at morne and euen, like the North diall in the 17. Chapter, or at least but in some part of the yeare, whiles the Sun is in the lowest signes in the winter quarter, which happily might breed some difficulty to yong practisers.

I haue therefore thought good to let them vnderstand, that the selfe same dyall made to any reclining plaine, will serue to his vnderface or inclining plaine, but turned vpside downe, and the numbers set to the howers altered accordingly: As for example. The dyall to the vpperface of the reclining plaine T. D. of the 14. Chapter, being but turned about (cocke and all the vpside downwards) will serue to the inclining plaine of his vnderface, altering onely the numbers set to the howres, viz. that which in the one is 12. of clock at noone, must in the other be 12. of clocke at midnight, as you see there D. E, whose inclination is equall to the inclination of the vnder face of T. D.

Wherefore seeing euery plaine hath two faces, make alwaies your dyal on paper, to the vppermost face, as before hath bin taught, and then turning the patterne about before

you

you set to the numbers for the howers, the same shall serue for the vnderface. And if your reclining plaine do also decline, then will your patterne serue for fowre dyalles, as if your reclining plaine do decline East, the patterne turned about serueth to his inclining plaine, as before is said, and the backe side of the same patterne (the paper being oyled or pricked through) will serue you to the like reclination and inclination declining as much West. If this may not suffice resorte to the 2. Booke: wherein euery thinge you shall be more curiously satisfied.

Chap. 25.

Of sundry accidents that may stumble a young dyal maker.

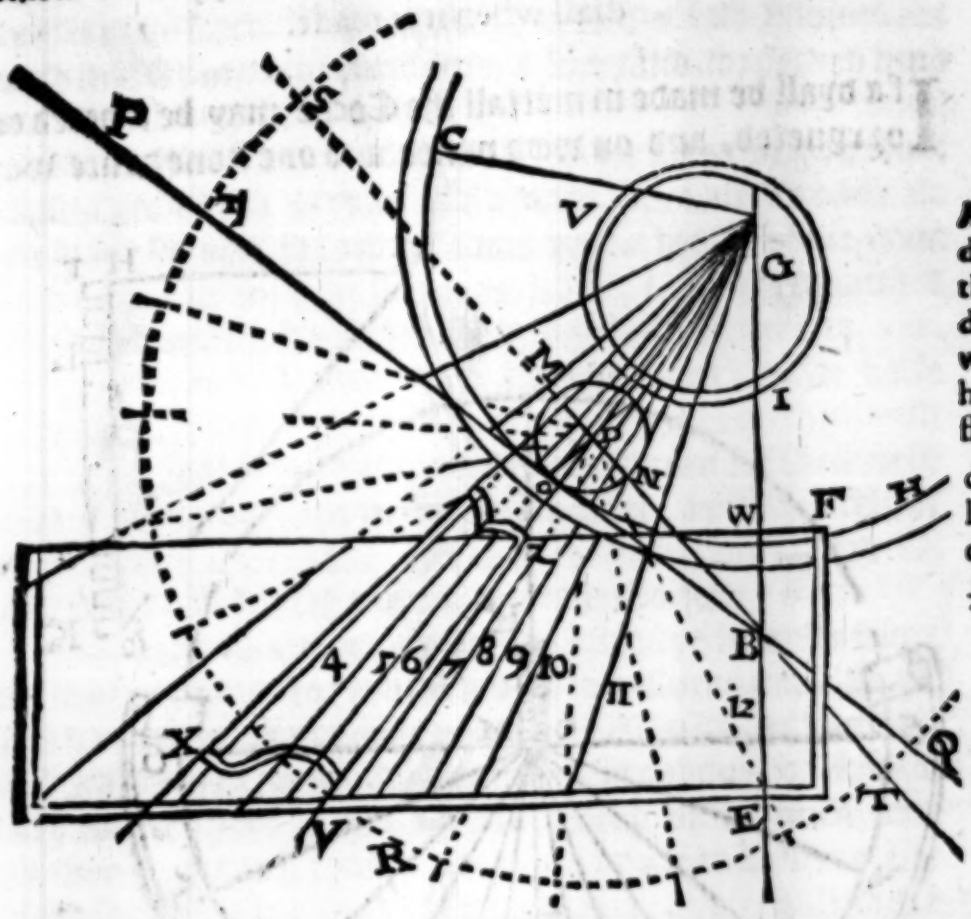
First when the elevation or rockes height of any wall or plaine falleth out to be very smal, as in this figure, being a dyal to a Mural plaine worying from the South 75. degrées towards the West. Then will D. D. the Semi-diametre of the Equinoctiall circle H. D N. be so short, that hardly can that circle be deuided iustly into 24. equall parts, much lesse euery parte into quarters, as the ende of the 2. Chapter teacheth.

To remidy this, you shall on D. the centry of your Equinoctial circle H. D. N. discribe a consentricke circle, as large as you lifte, and then deuide him into 24. parts, by which parts lynes extended from D. the common centry shall both deuide the Equinoctiall circle H. D. N. iustly, and also crosse the touchline P. D. M. exactly.

Secondly in all dyals to such plaines, the howerlines grow so exceeding nere together, that except the dyal be huge they will hardly serue to good vse.

To remedy that, you shal extende the howerlines a great way beyond the dyall circle C. D. H, and then cut them off and the cocke withall, with along square, as E. F. in this figure,

gure, so will it shew almost like the right Horizon diall of the 15. or 23. Chapters: for the hower lines will be almost parralell.



A Murall Dyal declining from the South, 75. degrees towards the West his angle of deflection 37. ½ degrees. his equation or cockes higgt 9. ¼ degrees,

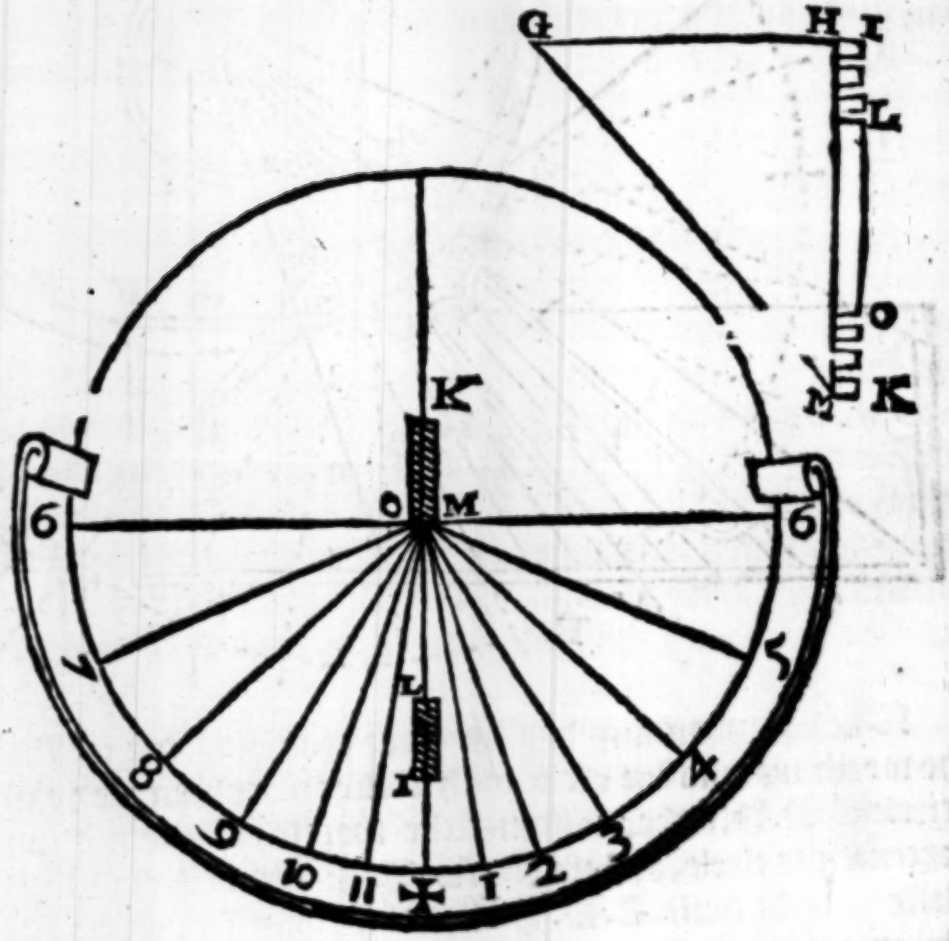
Thirdly, when any dyall is made, you may cut off the hower-lines, and the cocke with a lesser circle then the dyall circle C. D. H, either concentricke thereto, or else with an ercentricke circle, as here you see M. I, and so make a diall lesse then the circle C. D. H. by which you framed it: or by extending the hower-lines you may cut them off, either with a greater concentricke circle, and so make a bigger diall then C. D. H. or else you may cut them off with a square or triangle, or any other forme you thinke fit.

CHAP. 26.

How to faſten in the Cocke of any diall when it is made.

If a dyall be made in mettall the Cocke may be ſodered on or ryueted, and on wood nailed, and one ſtone a ſure way

South wall
yall where
e latitude is
r. degrees 40.
inutes.



is to poze in hot lead into ỹ channel, but when the ſtone is fixed in any vpright wall, then cannot the hot lead be fitly

pozed

powred in, and therefore first I practised to fasten it with Simon made of ware & Rosen, but that proued starke naught: for the weather rotteth the Synon in short time and maketh it of no force. The best way, which at last I found, is with morter made of stone-lime & fine sand, for slecked lime is of little strength.

But first let your Cocke M. H. G. be made of good thick brasse plate or else of yron. And vnto his base line M. H. you shall allowe a bredth of some ynche for a foote to your Cocke, to be let into the stone, as K. M. I. H. then with a file, slit downe three notches in this foote at either end, viz. betweene K. and O. and I. and L. each notch to be halfe inche asunder and better. So haue you at each end three teeth like the teeth of a saw, but that they are square. let these teeth be bent aside, some one way some another, as in the teeth of a saw is vsed. the residue of the foote betweene L. and O. to remaine leuell with the plaine of the Cocke.

Then grate or groue in a channell so deepe into the stone as this foote M. I. in the line where this Cocke must stand, which done you shall vndermine the bottom of the channel, on both sides to make it wider there then aboue, for the said teeth to catch hold in. This channell must be so much longer then your Cocks base M. H. by so much as K. O. is, the which space K. O. and also a space for L. I. you shall make as wide at the top as at the bottome, to the end you may by them two wide places, K. O. and L. I. let in the said teeth of the Cocke into the bottome of the channell M. H. and then the Cocke, must be driuen with a light hamer, till his base line M. H. sit euen w̄ the Semidiametre, M. ✛, so shal the teeth hold fast within the grous of the stone, in manner of a doues tayle that ioyners vse.

All things thus fitted, then fill the channell being well clensed from dust, with the foresaid morter not made ouer stiffe, for the stone will dry it in too fast, and then thrust in your Cocke downe to the bottome, and driue him iust to his place, as aforesaid, then with a knife smoth that squiseth

forth and make all plaine. Lastly to fasten him the more sure you shall wedge him in with thin Oister-shels driuen into the channell one both sides, but so that alwaies you guide your Cocke by the helpe of a setting squier, so applied that he may stand iustly perpendicular, or plum from the wall, as the 9. Chapter teacheth, and if he leane any way, then driue your Oister-shels the more on the contrary side, till he come euen with the squier, but beware you driue no Oister-shelles vppon the teeth, least you vnbend them:

Note that if your dyall be large, you shall make two teeth more in the middle of the Cocks base, to be let into the channell as the other.

The End of the first Booke.

THE

THE ART OF DY-ALLING.

The ſecond part, teacheth by a more Artificiall way to make Dyals, not onely to all Horizons, walles, or other plaines, howſoeuer declining, reclining, or inclining: but alſo to concaue and conuex plaines, and to ſet the 12. ſignes and the howres of any other country in any dyall, and many other things to the ſame Art appertaining.

Wrought by diuerſe newe conceites of the Author, neuer yet extant by any other.

CHAP. 1.

How ſpeedily with rule and compaſſe to make an angle, containing any degrees aſſigned, or to get the degrees of any angle made.

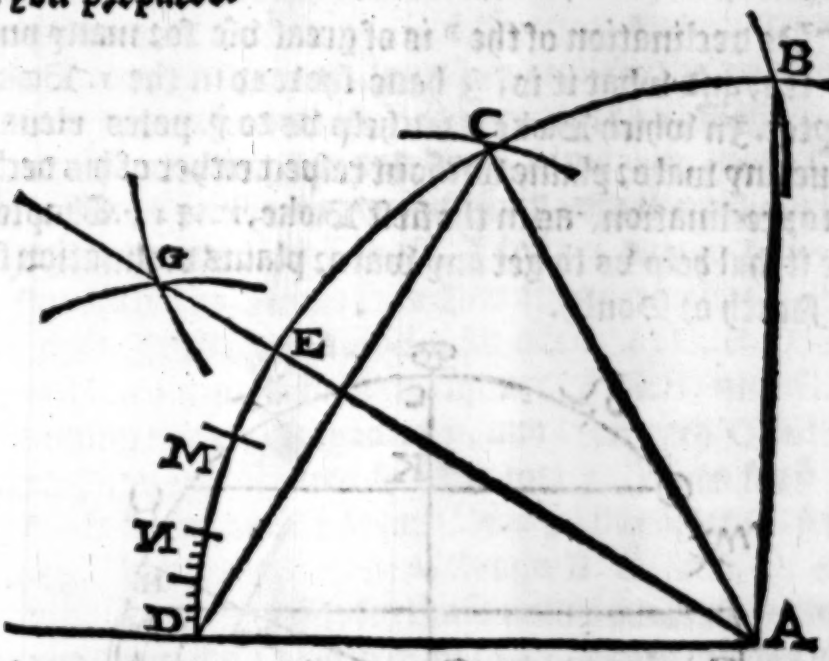
IN the firſt part, I haue as I promiſed, taught mechanically, as it were to make all Dyals after the plaineſt way with helpe of a quadrant, and of an inſtrumēt prepared for that purpoſe, as the firſt Booke, 4. Chapter teacheth: But in this ſecond part I wil teach to performe the ſame moſt artificially, and that without helpe

of quadrant or any instrument other then your rule and compasse, which also for the first way must be had: because instruments are either combersome to carie, or not at hand when we neede them: yea though you haue neither rule nor compasse about you, and should be requested to make a dyall in any place as you trauell, I will yet shew you meanes, as followeth, to get notes sufficient to make the dyall by when you come home, where your rule and compasse are, and after send it to the place, as I often did.

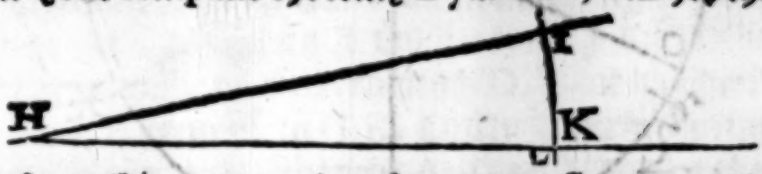
A man of Art I know may easily performe any actions Mathematicall with his rule & compasse: but for this action it shall be sufficient for the learners onely to know how speedily with rule and compasse to make an angle containing any number of degrees assigned, or of any angle made to know the degrees: for which purpose, it were very good that you had a Sextans of a circle described on your rule, and divided into 60. degrees, as here you see A.B. on the rule E.F. for the cord of 60. degrees, viz. A.D.B. is alwaies equall to the semy Dyametre of the circle.

But for want of that readinesse on your rule, open your compasse to any fit width, when occasion serueth, and therewith on some point as A. describe an arch of a circle, and then your compasse vnstirred, make two markes therein, as D. and C, and draw A.D. and A.C. and C.D, now is A.D. or A.C. your semy Dyametre, and the cord C.D equall to either of them, and the arch C.D. shall containe iust 60. degrees, then open your compasse at a venture, to somewhat more then halfe C.D, therewith on C. and D. describe two arches crossing without C.D. at G, and extend A.G. cutting D.C. at E. so shall D.E. and C.E. be equall, and either of them

30. degrées, therefore if you doe set C. B. beyond C, equall to C. E. or E. D, and draw A. B, so haue you a quadrant A. B. D. quickly made, then deuide D. E. into three parts at M. and N, then deuide N. D. into 10. equall parts, so are you prepared.



Now if you desire an angle admit of 14. degrées, first take in your compasse the semy Dyametre, A. D, or the cord



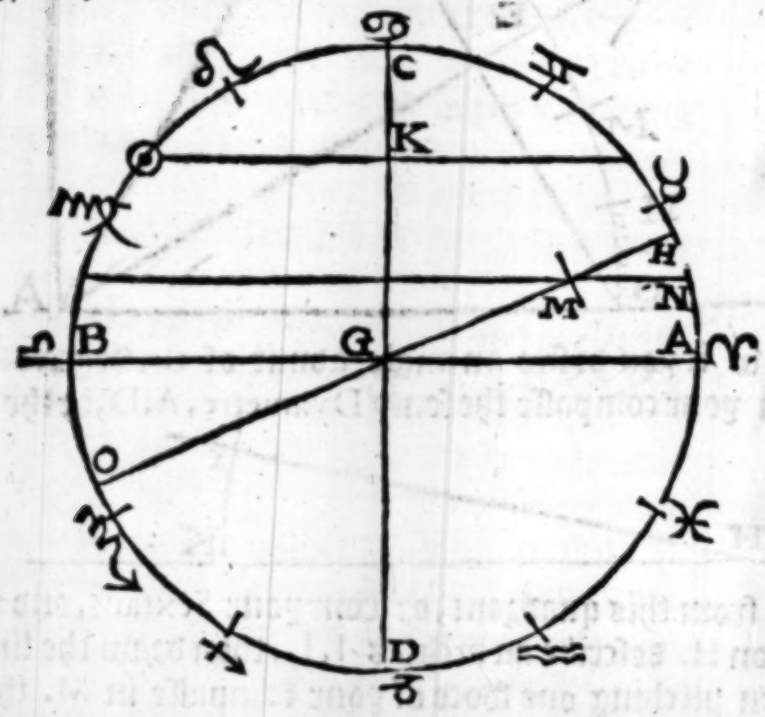
C. D. from this quadrant, or from your Sextans, and therwith on H. describe an arch, as I. L, then draw the line H. I. then pitching one foote of your compasse in M. thence extend the other to the fourth diuision or degree beyond N, so haue you 14. degrees: for M. N. is 10. set them in this arch I. L. viz. I. K. and draw H. K. so is I. H. K. an angle of 14. degrees desired, if 20. degrées be desired, then E. N. or M. D. doe serue, if 30. then E. D. or E. C, if 40. then. C. M, if 50. then C. N, and so of any other.

Chap. 2.

Chap. 2.

How to get the declination of the Sunne by rule and compasse, and help of an Almanacke.

The declination of the ☉ is of great vse for many purposes, and what it is, I haue shewed in the 1. Booke, 5. chapter. In which Booke it did help vs to ỹ poles elevation aboue any wal or plaine without respect either of his declination or reclination, as in the first Booke, 12. & 13. Chapters, & here it shal help vs to get any wal or plains declination from the North or South.



But because we will not be tyed to the instrument of ỹ 1. booke. 4. chapter, or any other you shall take any common Almanacke, there shall you finde on what day of each moneth the ☉ entereth euery of the 12. signes, then reckon for euery day after, till you come to your day desired, one degree and so many degrees of that signe, you may say ỹ the Sunne is in that day sufficient for this purpose: Yea rather then faile, if an Almanacke be wanting, a man may do it

it by heart, because the Sun entreth euery signe about the 11. or 12. day of each moneth, specially either fiue weekes before Midsummer, or 3. weekes after: for then the ☉ being in his sommer Solstice varieth not his declination 5. minutes of a degree in three daies, and then is the best time for this action.

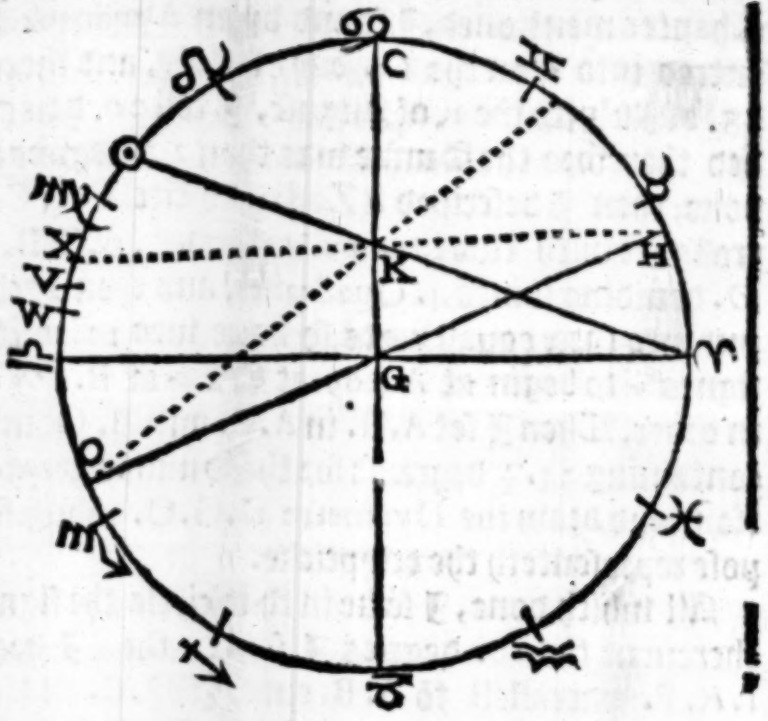
For example, the 2. of August, 1604. for the dyall on S. Laurence Church wall in Reading, in the 1. Booke, 13. Chapter mentioned, I found by an Almanack that ♈ Sun entred into ♋ on the 12. day of July, and there from that 13. of July, to the 2. of August, I tell 20. daies, I concluded therefore the Sunne was then 20. degrees in ♋, this done, then I described a Zodiacke circle A. C. B. D. and crossed it with two Dyametres square, A. G. B, and C. G. D. deuiding it into 4. Quadrants, and then each Quadrant put into three equall parts, so haue wee 12. parts for ♈ 12. signes ♈ to begin at A ☌ 69. at C. ☌ ♎ at B. ☌ ♑ at C. ♈ rest in order. Then I set A. H. in A. C. and B. O. in B. D. each containing 23. ½ degrees: for the Sunnes greatest declination, and draw the Dyametre H. G. O. which for this purpose representeth the ecliptick.

All which done, I seeke in that circle the signe Leo, and therein at the 20. degrees I set I. then I draw the line I. K. P. parrallell to A. B. cutting D. C. at K, then I set G. M. in G. H. equall to G. K. Lastly I draw the line M. N. parrallell to A. B. cutting A. C. at N. I say that A. N. is ♈ Sunnes declination sought, which as the 1. Chap. teacheth, shall be found to be 15. degrees, and that Northwards, because ♋ is a North signe, as in the 1. booke 5. Chapter is shewed. Note that you may performe the whole by one Quadrant, as A. G. C. if you set the whole 12. Characters therein, numbred twise vpwards & downewards.

CHAP. 3.

To performe the same another way, by a newer conceit of the Author.

HAuing gotten the Sunnes place and planted it in the Zodyacke circle, A. C. B. D. at I. and drawne the ecliptick O. G. H, as in the last chapter, you shall then extend the line A. I. cutting ☌ line C. D. at K. then extend O. K. to cut ☌ circle at Y. & H. K. to cut it at X. now marke which is ☌ bigger of H. Y. or O. X. which here is O. X, set therefore O. W. in O. X. equall to H. Y. then deuide W. X. in halfe at V. I say that now B. W. is the declination sought, which by the 1. Chapter you shall finde to be 15. degrees, as before, and that northwards from B. G. A. which here representeth the Equinoctiall.

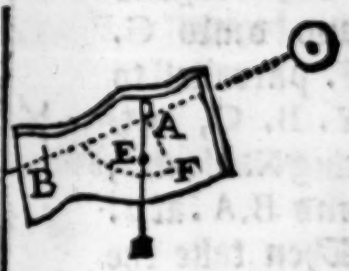


But if the degree of ☌ ☉ had beene betweene ♎ and ♈, viz. in the semycircle B. D. A, then will your working be all vnder the line B. A. and the declination gotten, is southwards.

CHAP. 4.

How to take the altitude of the Sunne without Instrument.

TAke a trencher or any simple bords end, of what fashion soeuer, such as you can get, make therein two prickes, as A. and B. then knocke in a pinne, naile or short wyer in the one point A. plumme vpright hang thereon a thrèd with a key or stone or a tile shard in stèd of a plummet: then lift vp this bord towards the Sun till the shade of the pin at A. come directly on the point B. there marke a point, viz. E. directly vnder the thrèd. Then take out your pinne at A. and carry home your sory bord with his thrèe points, A. B. and E. there with your rule & compasse draw the lines A. B. and A. E. and make a Quadrant B. A. F, as the 1. Chapter teacheth, so shall the angle E. A. F. by your altitude desired. Or else you might haue pinned the trencher or bord into a shèete of paper, & so wrought vpon the paper, and leaue your bord behind, and carry home but the paper.

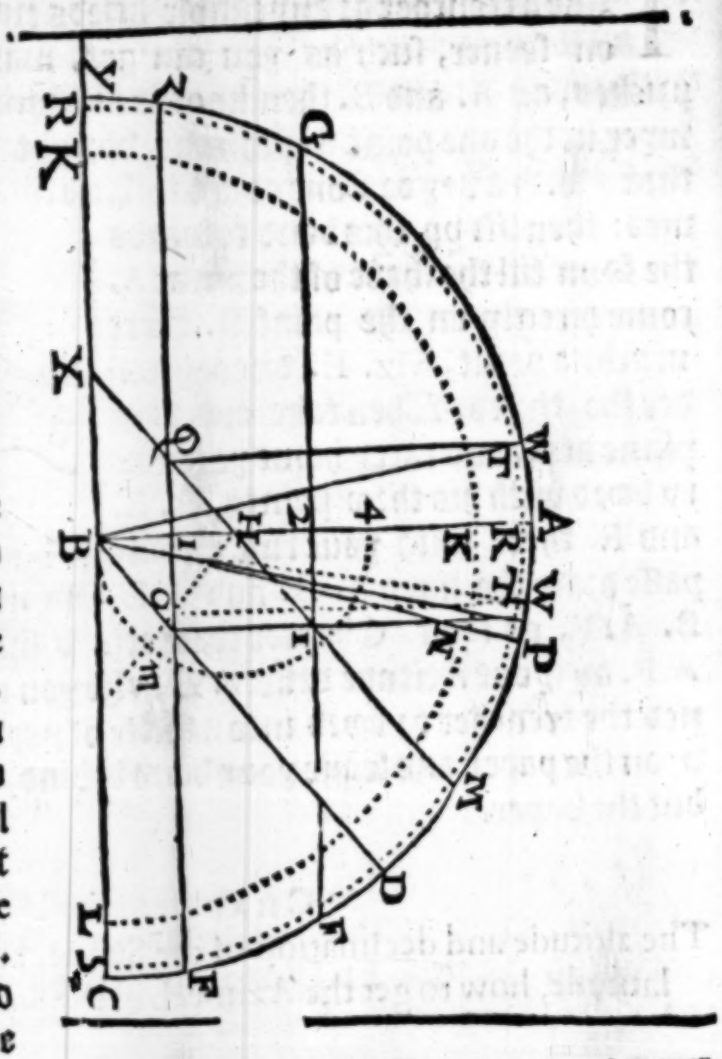


CHAP. 5.

The altitude and declination of the Sunne, had in a knowen latitude, how to get the Azimuth of the Sunne.

FOr example. Admit the second of August, 1604. for the Dyall in the second Chapter mentioned the altitude of the ☉ taken in the morning, to be 30. degrées, gotten by the last Chapter or by the first booke tenth Chapter. Then describe the Semy-circle, as Y. A. C. on the Centre B. then on B. erect the Semy-dyametre B. A. square to Y. B. C. then set A. D. in A. C. equall to your latitude, and draw

B. D. then if the Sunnes declination gotten by the second or third Chapters shall be North, as in this example it is, you shall set D. M. in D. A. equall vnto it, viz. 15. degrees, but if it had beene South, then D. M. must be set in D. C, then draw the line M. X, parrallell to B. D, cutting B. A. at H. This done, set C. E. in C. M. equall to your altitude gotten viz. 30. degrees and draw G. F. parrallell to Y. B. C, cutting X. M. at I, and B. A. at 2. Then take the space 2. E, and therewith on B. describe the Semy-circle K. N. L. Then from I. extend a line parrallell to B. A. to cut the Semy circle K. N. L, at N. Lastly extend B. N. to cut the Semy-circle Y. A. C. at P. I say now that C. representeth the South point of the Meridian line Y. C. and therefore C. P. shall be the Azimuth desired, that is to say, the Horizontall distance of the Sunne from the South point C. at the instant proposed. which by the first chapter you shall finde to be 76. degrees, or thereabouts.



Note that if the same day, either in the morne or euen, (which

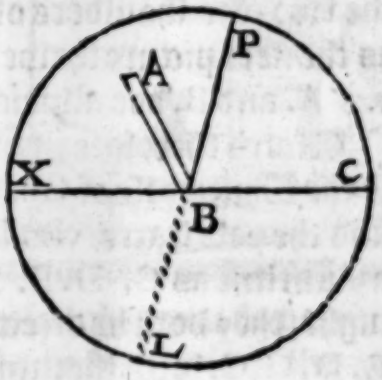
(which times indæde are the best for this practise) you had found the altitude but 10. degrees, as C. F. and draw Z. F. cutting B. A. at 1. and X. M. at Q. then proceeding as before, you shall get Y. W. 77. degrees. 45. minutes, which is the Sunnes Azimuth from the north point Y. but indæde for south declining Dyals, it is better to take C. W. viz. 102. $\frac{1}{4}$ degrees, the Suns Azimuth frō the south. and if you were willing to work all within the Quadrant A.B.C. then make the angle B.H.M. equal to 4.H.M. so shal H.M. cut 1. F. at O. so is H.I.O equal to H.I.Q. & so may you get C.W. in the Quadrant A.B.C. equal to Y.W, before gotten, whereby C. may represent both the North and South point.

Chap. 6.

How speedily to draw the Meridian line the Sunne shining.

I Haue in the first booke 11. Chapter taught to draw the Meridian line on any plaine by a daies observation; but here wil I shew to do it presently on the plain of your Horizon, but in this 2. booke we haue no vse of it, but onely for the Horizon Dyall.

Describe a circle as C.P.X.L. on the plaine of your Horizon, on his centre B. erect a stile or wyer plum vpright, as the 1. booke, 9. Chapter teacheth, directing to your Zenith, then either in the morning or in the euening (which times as I haue said are the fittest times to take the altitude of the Sunne, as the 4. Chapter, or the 1. booke 10. Chapter teacheth, which admit you find in the morning to be 30. degrees high, then mark where the shade of ỹ stile cutteth the circle C.P.X.L. admit at L. then draw the Dyametre L. B. P. which done, get



the Azimuth or Horizontall distance of the Sunne from the North or South, as the last Chapter teacheth, which admit you finde 76. degrees from the South, then by the 1. chapter set C. southwards from P. so many degrees viz. 76. & draw the Dyametre Y.B.C. which I say shal bee your Meridian line desired: but if the Azimuth had beene from the North, then must you haue set C. North-wards from P. & so haue drawne your Meridian line, which Meridian so drawn you may ỹ day following set vp two poles directly euen wᵗ the Sunne beames at the very instant, when you finde the shade of the stile A. B. to fall vpon the line B. Y, which may stand you in stead for many purposes.

CHAP. 7.

To performe the same in the night, by the pole starre.

THe outermost starre of ỹ taile of the constellatiō, called Vrsa minor, or the little beare, is commonly called the pole-starre, or Cinosura; viz. D. but the true pole of the world is a point inuisible fixed in the heauens, in this age three degrees distant from the pole starre, viz. at G. which starre D. any man of art will shew you for the asking: and in a starry night, looking Northwards, this picture may almost teach it you: for the two great starres, called commonly the hinder wheeles of Charles-waine, but are indeed the two fore shoulders of the constellation of Vrsa maior, as the next picture sheweth. I say those two great starres, viz A. and B. doe alwaies direct to the pole starre D.

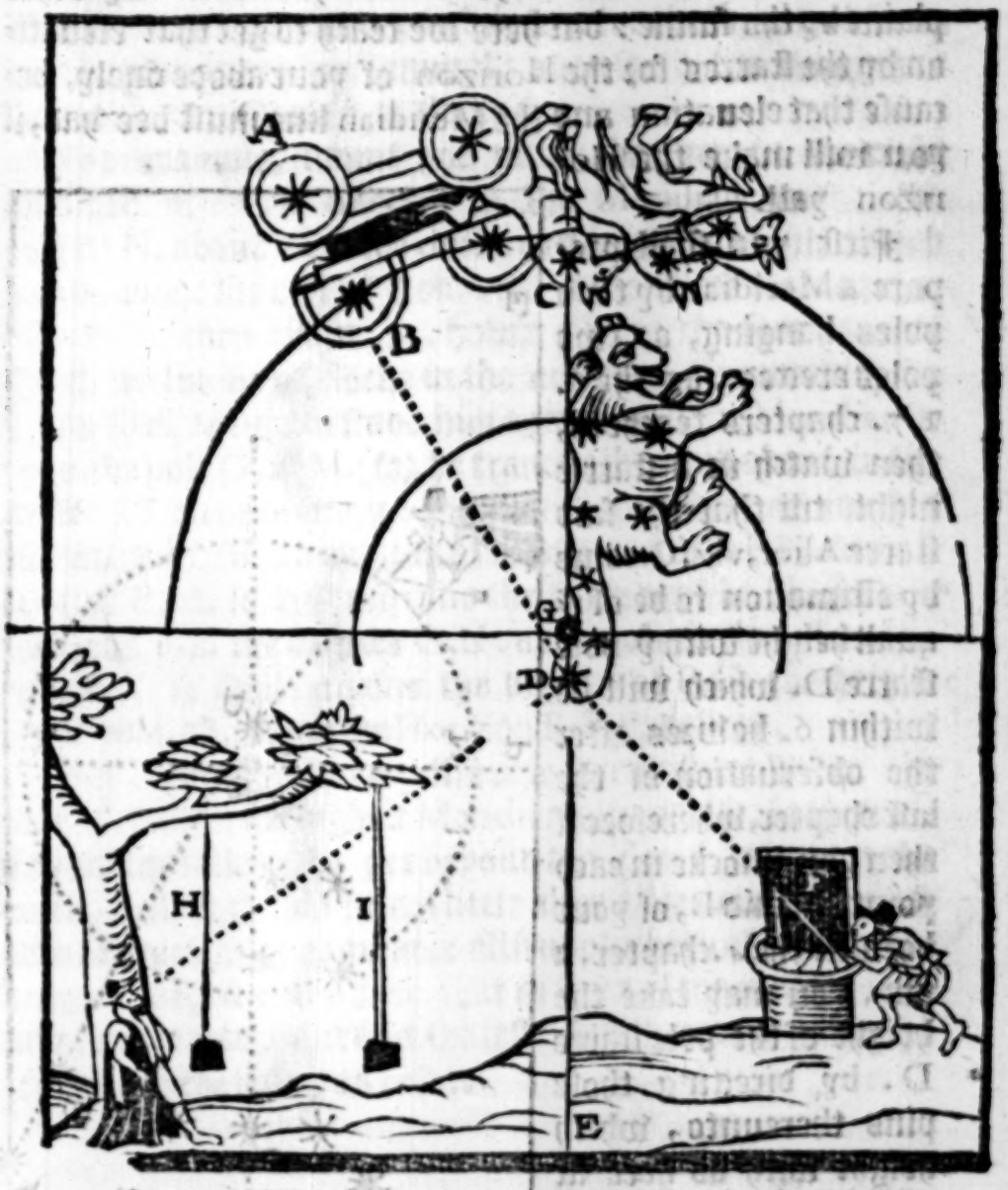
Watch therefore in a starry night, when the starre that is the Thill-horse of Charles waine, called the Alliot, viz. C. and the pole starre, viz. D. be directly one aboue another, by a plum line as C. D. E. Then be sure at that time of the night, they both be directly North, euen in one vpright line, E. D. G. C. with the inuisible pole G. wherefore by a square bord or trencher, as F. then directed to them by your eye-

beame

beame, you may reddily ſtrike out a Meridian line.

By this meanes I did vſe to plate Horizontall dyals as truly by night as by day, and more ſpeedily.

Or you might then haue hanged two cords made blacke, or erected two blacked poles directly with thoſe two ſtarres,



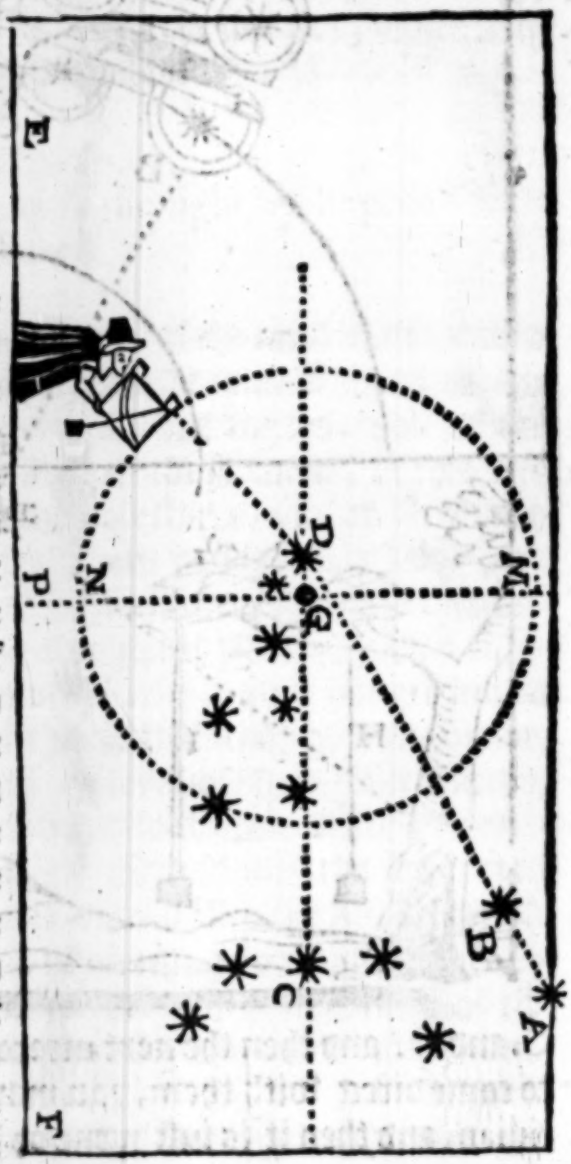
C. and N. and then the next morrow when you finde the ☉ to come direct with them, you may be ſure he is in the Meridian, and then it is iuſt none or 12. of clocke.

Chap. 8.

Chap. 8.

How to get the latitude or poles eleuation in any place by the ſtarres.

I haue in the 1. Booke, 13. chap. taught how to get the poles eleuation, either aboue the Horizon, or aboue any other plaine by the ſunne: but here we teach to get that eleuation by the ſtarres for the Horizon of your abode onely, becauſe that eleuation and the Meridian line muſt bee had, if you will make the Horizon dyall.



Firſt you ſhall prepare a Meridian by two poles hanging, or two poles erected, as the 6. & 7. chapters teacheth, then watch in a ſtarrie night, till that the ſaid ſtarre Aliot, viz. C. come by eſtimation to be of equall height with ỹ pole ſtarre D. which will be within 6. howres after the obſeruation of the laſt chapter. Wherefore if then you knocke in each point, A. and B, of your bord in the 4. chapter, a pin, you may take the height of the pole ſtarre D. by directing thoſe pins thereunto, which height with vs here at Reading, is found 51. degrees, and about 35. or 40. minutes, ſo haue

you

you the true height of the inuisible pole G. aboue your Horizon E. F, because euery part of the imagined line D.G.C. is then of equall height from E.F.

You may also get the same height of the pole by helpe of any other starre that you finde vnder the pole, though you know him not, so that you haue two poles, or two cords set Meridian wise, as the 6. & 7. chapters teacheth, and obserue his altitude when hee commeth euen with the two cords as well vnder the pole as aboue.

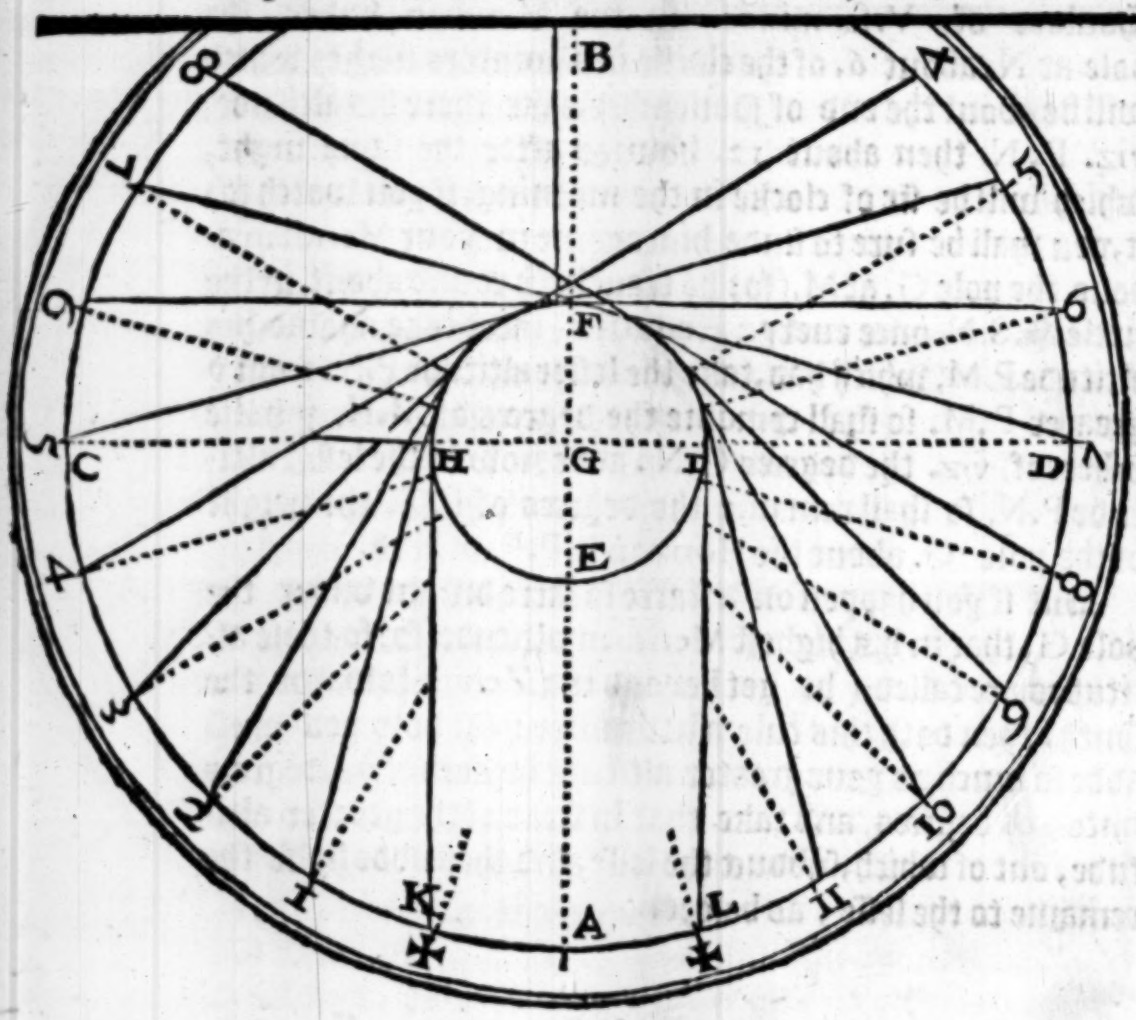
For example, admit you finde the starre in the right shoulder of Vrsa minor, in the Meridian vnder the pole at N, about 6. of the clocke in a winters night, which will be about the end of November, take there his altitude, viz. P.N. then about 12. howres after the same night, which will be six of clocke in the morning, if you watch for it, you shall be sure to finde him againe in your Meridian aboue the pole G. at M. (for he trauelleth round about in the circle M.S.N. once euery 24. howres) there take againe his altitude P.M, which had, take the lesser altitude P.N. from ŷ greater P.M. so shall remaine the degrees of M.N. ŷ halfe whereof, viz. the degrees G.N. adde now to the lesser altitude P.N. so shall remaine the degrees of P.G. the height of the pole G. aboue the Horizon E.P.F. desired.

But if you happen on a starre so farre distant vnder the pole G, that in his highest Meridian altitude (for so these altitudes are called) he get beyond the Zenith towards the south, then doth this rule a little alter: for now you must adde so much as your greater altitude lacketh of 90. degrees vnto 90. degrees, and take that in stead of the greater altitude, out of which, subduct the lesse, and then adde halfe the remaine to the lesse, as before.

Chap. 9.

Of the Polare and Equinoctiall, or right Horizon dyals.

I shewed in the 1. booke, 1. chapter, ỹ the dials to al Horizõs & plains can be but of 3. sorts, viz, either Polare, Equinoctiall, or Oblique: For fabrication of the two first, they are so easie, that no more can be said, then in the 1. Booke, 15. and 16. chapters is deliuered: but an ingenious practiser may transforme them into diuerse fashions, as well con-



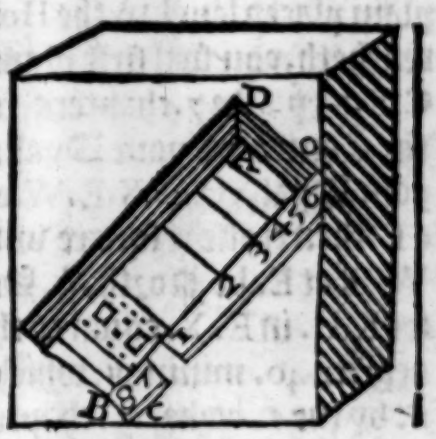
North.

caue as other. My selfe once for that the stile of a Polare dy-

all

all can be but a sleight wier erected in the centre, did therefore in stead thereof set a short columne, and to frame the dyall thereto, I described a circle on the dyals centre G. viz. H.I.E.F. equall to the base of the columne, and then hauing put the semy Circle C.A.D. of the dyall into 12. equall parts in blinde lines, as the said 15. chapter teacheth, I did draw touchlines to the circle H.E.I.C. parrallell to euery blinde howre line, which doe serue for the howre lines of ỳ dyall, and set numbers to them, as this figure sheweth, better then many words, as for 4. and 5. at morne, they are in one streight line with the foure and fiue at euen, and so of 6. and 7. at night.

Euen so, for an east or west wall or any Equinoctiall or right Horizon dyall, if they bee to bee made in stone, you may growe a plaine as A.B. into the stone parrallell to the vpper plaine, C.D. and let the thicknes of the growe be the gnomon, as B.D.



Many other such like an ingenious practiser may easily finde.

Chap. 10.

How in any Oblique latitude to make an Horizon dyall, or a dyall to any wall, or to any reclining plaine, which declineth not from the north or south, by a new conceit of the Author.

It may appeare by the 1. Booke, 14. and 17. chapters, ỳ in all Oblique dyals that decline not, two things must be had before you can make the dyall, viz. the Meridian or 12. of clocke line, wherein the cocke must stand, and the eleuation of the cocke aboue the same line.

In euery latitude there can be but two walles that decline not, viz. the north and south walles in them, (yea and

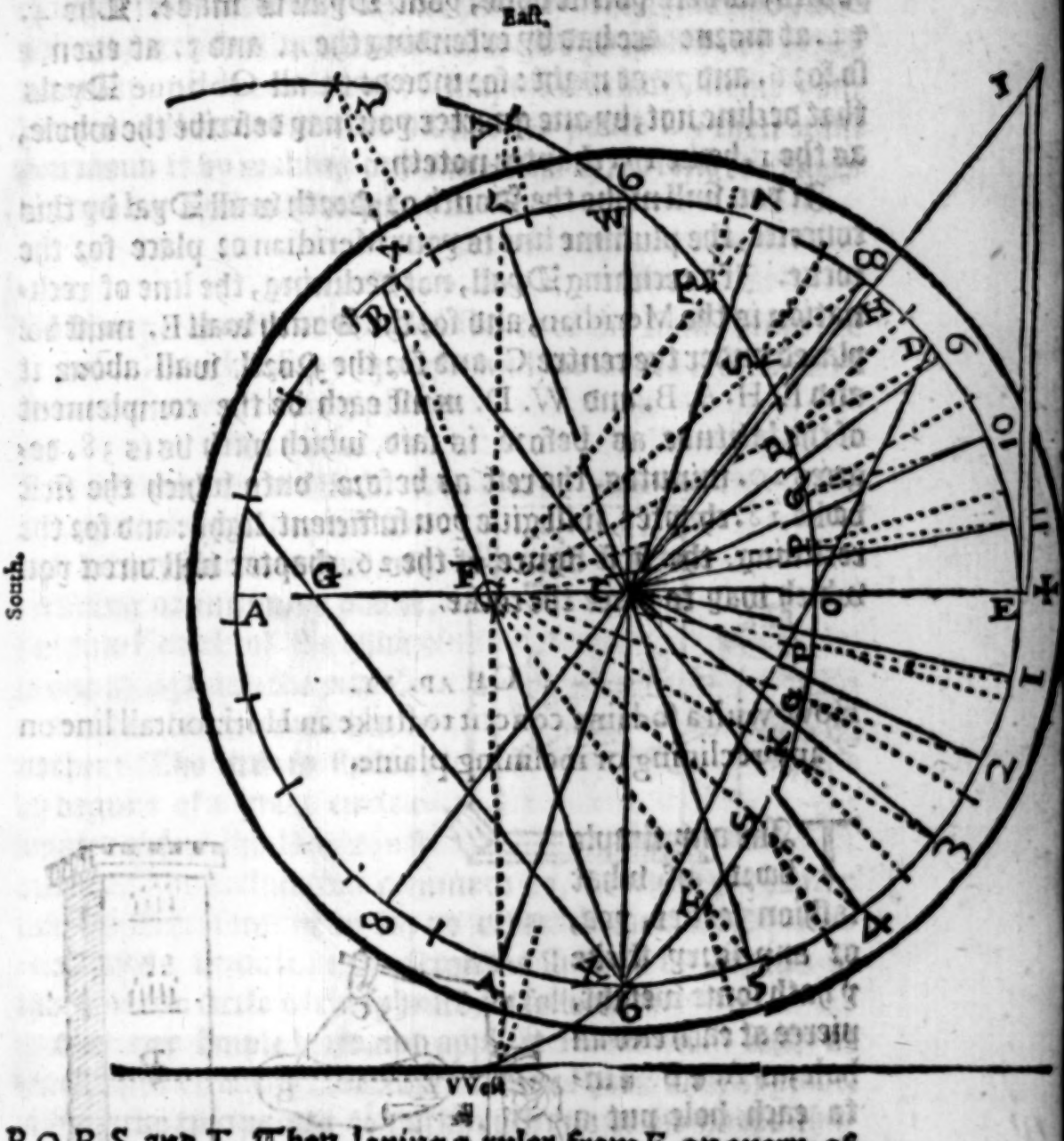
in all other plum erected walles or plaines) the perpendicular or Verticall line. is also ỳ Meridian or twelue of clock line, and therein the cock must stand, and in those two the height or eleuation of the cocke is alwaies certaine, so many degrees as the latitude wanteth of 90. degrees. And for all reclining or inclining plaines, that decline not the line of reclination or inclination is their Meridian and line for the cocke: as for their cockes eleuation, the 1. booke 14. Chapter teacheth readily to get the same.

Seeing therefore the maner of making of all these are all after one, we will here proceed to make an Horizon Dyall to our latitude here at Reading. Hauing therefore a plain placed leuel wᵗ the Horizon, as the 1. booke 9. Chapter teacheth, you shal first plant thereon your Meridian line A. C. E. as ỳ 6. or 7. chapters teacheth, and therein point C. for the Centre of your Dyall, and thereon describe a circle for your Dyal, viz. A. X. E. W. cutting your Meridian A. E. at A. & E. then crosse it square with ỳ east line or Dyametre X. C. W. Let E. be North, A. South X. East, & W. West. Then set E. H. in E. X. equal to the latitude, which with vs is 51. degrees 40. minutes, which you must get by the 8. chapter, or by the 1. booke 13. chapter, and extend C. H. then from E. extend E. I. perpendicular to E. A. crossing C. H. extended at I. so is E. I. the height of your cocke aboue C. E. and C. E. I. the iust patterne for your cocke.

Which done, set W. D. in W. E. and A. B. in A. W. each equall to E. H. your cockes eleuation, then extend ỳ lines X. D. cutting C. E at O. & X. B. cutting A. C. at F. Then from X. extende a line to crosse C. A. at G. so that it make with X. F. an angle, F. X. G. equall to C. X. F. as the first chapter teacheth. Lastly from G. extend your compasse to X. or W. and therewith describe the excentricke arch X. O. W, which if you haue wrought truly, shall iustly cut ỳ point O, let this be the first part.

Being thus prepared, diuide now the two quarters of your Dyall circle X. E. and E. D. W. each with 5. points, into

into 6. equall parts, on euery of which a rule being laid from C. you shal diuide therby the excentricke arch X. O. W. into 12. vnequal parts, marked on each side of O. with 5. points



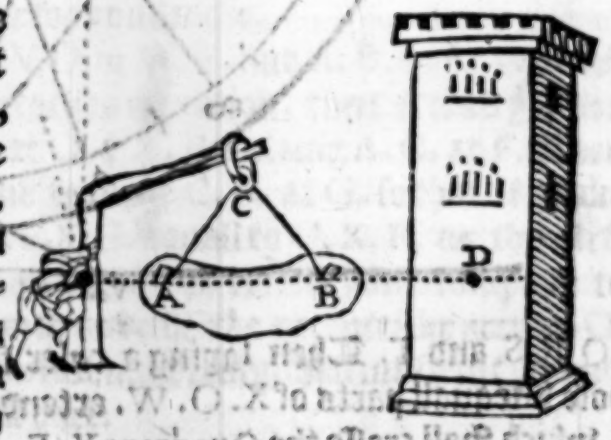
P. Q. R. S. and T. Then laying a ruler from F. on euery of those vnequall parts of X. O. W. extende blinde lines from F. which shall crosse the Quadrant X. E. at 1. 2. 3. 4. and 5. and the Quadrant E. W. at 7. 8. 9. 10. and 11. which points

of crossing with X.E.W. do limit the width of euery of the 12. howers, answerable to those numbers set to, wherefore if from your Dyals centre C. you extend lines to those points, as here you see done, your Dyall is made. The 4. & 5. at noone are had by extending the 4. and 5. at euen, & so for 6. and 7. at night: for indeede in all Oblique Dyals that decline not, by one quarter you may describe the whole, as the 1. booke 17. chapter noteth.

If you will make the South or North vvall Dyal by this conceite, the plumme line is your Meridian or place for the cocke. If a reclining Dyall, not declining, the line of reclination is the Meridian, and for the South wall E. must bee placed vnder the centre C. and for the North wall aboue it and E. H. A. B. and W. D. must each be the complement of the latitude as before is said, which with vs is 38. degrees 20. minutes, the rest as before, vnto which the first booke 18. chapter, will giue you sufficient light: and for the reclining, the first figure of the 26. chapter will direct you which way to place the cocke.

Chap. 11.

How with a sodaine conceit to strike an Horizontall line on any reclining or inclining plaine.

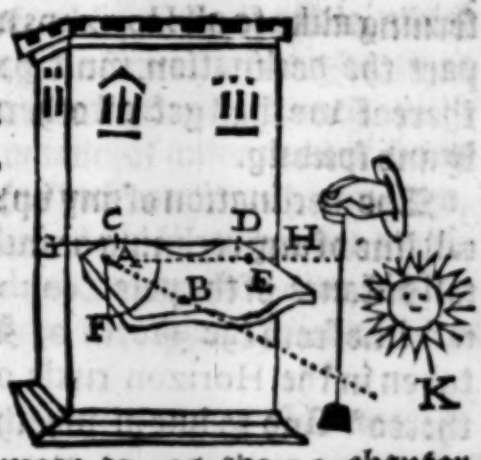


TAke any simple bord, of what fashion soeuer, yea, or any sorry sticke y hath some weight, pierce at each end an hole, as A. & B. & into each hole put a short pin, thē with a thred of som length fastened also to each hole, hang it vp on C. tryangle-wise, as A. C. B, so that by your eye set first to the point A. you direct

direct the two pins to some wall, making there the point D; Then turne about your boord so hanging, that the pin B. be nert your eie, and there direct the pinnes againe to ŷ wall, if now they hit on the former point D. then haue you a leuell prepared for this & many other good purposes, by which you may, as the 1. Booke 7. chapter teacheth, strike your Horizontall line: but if it hit not the point D, then must you mend it by making one end of the thred longer or shorter, and try againe till it hit.

Chap. 12.

How to get the Horizontall distance of the sunne from the pole Zenith of any vpright wall, or of the Horizontall line of any reclining plaine.



I shewed in the 1. Booke, 1. chapter, what the pole Zenith of any plaine is, but of a reclining or inclining plaine, the pole Zenith of the plaine is one thing, and the pole Zenith of his Horizontall line another: The first is shewed by degrees of a great circle eleuated aboue the Horizon so much as the reclination commeth to, as the 23. chapter will appeare, seruing vs for no other vse then for Equinoctiall dyals deuiating, the second is shewed by degrees of the Horizon circle of the spheare, as followeth.

Get any simple boord, and apply it Horizontall wise, or leuell vnto G.H. the Horizontall line of your wall or plain, and marke two points towards each end of the boord that doe touch the wall, as C. and D, the set the point A. towards one end of the boord neere the wall. Then hold a black thred and plumet in your hand, guiding it till the shade of ŷ sunne at K, hit on A, in which shade, there marke the point B, and

you

you haue done. Carie home this bord, and there draw A.E. parrallell to a line imagined betweene C. D. and also draw A.B. Lastly describe a quadrant E.A.F. as the first Chapter teacheth, so is B.A.F. the distance of the sunne at K. from F. the pole Zenith of the Horizontall line E.A. or C.D.

Chap. 13.

What the declination of any wall, or of the Horizontall line of any reclining or inclining plaine is, and how speedily to know whether they decline or no.

In the first Booke we taught how to get all complements for making dyals naturally: but somewhat tedious, and had there no vse at all of knowing the declination of any plaine, because the course there taught, was so downe right seruing alike to all Horizons and plaines: but in this second part the declination must principally bee had, for by helpe thereof we shall get all other complements more artificially and spædily.

The declination of any vpright wall, or of the Horizontall line of any reclining or inclining plaine is the Horizontall distance of the pole Zenith of any such wall or Horizontall line from the North or South paint of the Horizon taken in the Horizon circle of the spheare, by the degrees thereof. And to know whether there be any declination or no, thus doe.

If it be for a plum erected wall, draw thereon a Verticall line, as the 1. Booke, 6. chapter teacheth, if for a reclining or inclining plaine, draw thereon the line of reclination, as the 1. Booke 7. chapter teacheth, & in either of these two lines, erect a stile or wier very plum, as the 1. Booke, 9. chap. teacheth, then any day the sunne shining iust at 12. of clocke, (which time must be giuen by some very true clocke or dyall, or by the sunnes comming euen with the Meridian line, set, as the 5. or seuen chapters teacheth) then I say iust at 12. if you shall finde the shade of the stile to fall iustly on ỹ

said

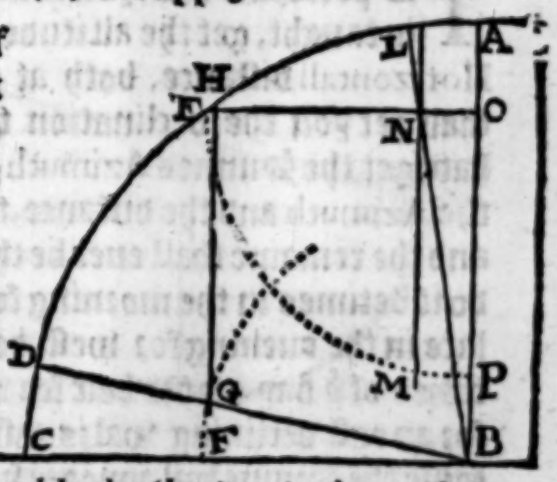
ſaid Verticall line, or line of reclination, then may you bee ſure that wall or plaine hath no declination at all, and that their pole Zenith lyeth in the very ſouth point of you Horizon: but this cannot be done for north walles, becauſe their 12. of clocke is midnight, and if the ſhade at 12. hit beſides thoſe lines, then be ſure there is declination, which and alſo which way, theſe chapters following ſhall teach to get.

Chap. 14.

How any day at noone the ſunne ſhining, without inſtrumẽt to get the declination of any vpright wall, or of the Horizontall line of any reclining or inclining plaine from the ſouth.

The common way heretofore vſed to get this declination, hath bene by helpe of a Magneticall nẽdle, which commonly varieth 11. or 12. degrees from the true North or South, & ſometimes loſeth the ſtrength of his touch, with the load-ſtone, or happily by meane of ſome yron at hand may ſtand awry: all or ſome of which commonly neglected, cauſed in times paſt many falſe dyals to be made: for I pulled downe one from S Laurence Church in Reading, which had there ſtode time out of minde, that went three quarters of an howre falſe.

Take now therefore any bord, and apply it Horizontall wiſe to the Horizontal line of your plain, viz. to G.H, mark 2. points towards each end that doe touch the wall, as you did in the 12. Chap. viz. C. and D. and towards that end of the bord fartheſt from the ſunne, & ſomewhat nere the plaine ſet the point A, thẽ iuſt at 12. of clocke gotten, as the laſt chapter teacheth, hold a blacke thred and plumet be-



tweene the ſunne and the wall, mouing it to and fro till the ſhade of the threed fall iuſt on A, then marke the point B. iuſt in that ſhade. Now if on this board you draw A.E. A B. and A. F, as was done in the 12. chapter, then muſt A: E. needs repreſent the Horizontall line G.H, being parrallell to it, and A.B. muſt needes be the Meridian, becauſe the Sunne at noone is euery day in the Meridian circle of the Spheare, and A. F. muſt needes point to the pole Zenith of the Horizontall line G. H, becauſe it ſtandeth perpendiculer thereto, and therefore the angle F. A. B. muſt needes bee the declination or Horizontall diſtance of the pole Zenith F. from the ſouth point B. which was deſired: but this way cannot ſerue for north declining plaines, for the cauſe in the 12. chapter mentioned: yet becauſe all plaines haue two faces, you may for a north face of any plaine take the declination of the ſouth face, and that will ſerue if you change the quarters, that is to ſay, if the ſouth face decline eaſt, then doth the north face decline as much weſt, *Et è conuerſo.*

Caap. 15.

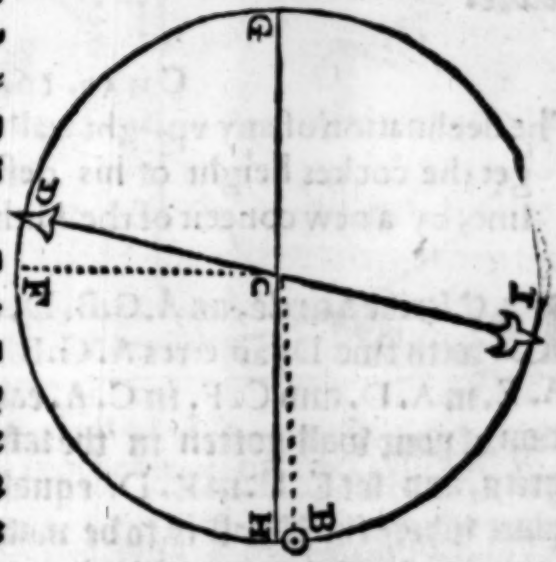
How to get the ſame declination any time of the day, either from the North or South, without Inſtrument.

TO performe this, you muſt as in the 4. or 12. chapters is taught, get the altitude of the Sunne, and alſo his Horizontall diſtance, both at one inſtant: for thoſe two ſhall get you the declination thus. Firſt, by the altitude had, get the Sunnes Azimuth by the 5. chapter. Then of the Azimuth and the diſtance, take the leſſe from the bigger, and the remaine ſhall euer be the declination deſired, ſo you do it betimes in the morning for eaſt declining walles: or late in the euening for weſt declining, becauſe thoſe two times of ỹ day are the beſt for this action in many reſpects: for an eaſt declining wal is eaſily knowne in Summer, becauſe the Sunne wil appeare vpon him, before 6. of ỹ clocke

in

in the morning, and a west declining for that the Sunne will shew on him after 6. at night.

For example. Let vs suppose the figure of the 12. chapter to be the Church wall of S. Laurence in Reading, in the 2. chapter mentioned, and that the second of August 1604. when I came thither, about 5. of clocke in the morning, I found the Sunne to shew thereon, whereby I knew that it declined eastwards: and suppose I then found the altitude of the Sunne by the 4. chapter 10. degrees high, viz. E.A.F. in that figure, and suppose the same instant, that by the 12. chapter I found the Horizontall distance of the Sunne frō the pole Zenith of the wal, to be 91. degrees, viz. ỹ angle F.A.B. in that figure. Hauing thus gotten the altitude and distance, I gat me home, and thus I proceeded first by the 2. or third chapter, I get the declination of the Sunne 15. degrees, viz. the Arch A. N. in the 2. chapter, and B. V. in the 3. then by the 5. chapter, and helpe of the altitude, viz. 10. degrees, I find ỹ Suns Azimuth then to be 102. degrees for the instant of the altitude taken. Now haue I that I desire, viz. 102. degrees the Azimuth sought for, and 91. degrees, the Horizontall distance before taken, now take the lesse of these out of the greater, there remaineth 11. degrees, the declination of the Church wall desired towards the East.



But because I would not leade you blindfold, neither tye you to any one time of the day so it be done any time before 11. of clocke, or after one, I will heere shew you by a simple figure, how you shall at

any time of the day do it, and conceiue the reason of your doing.

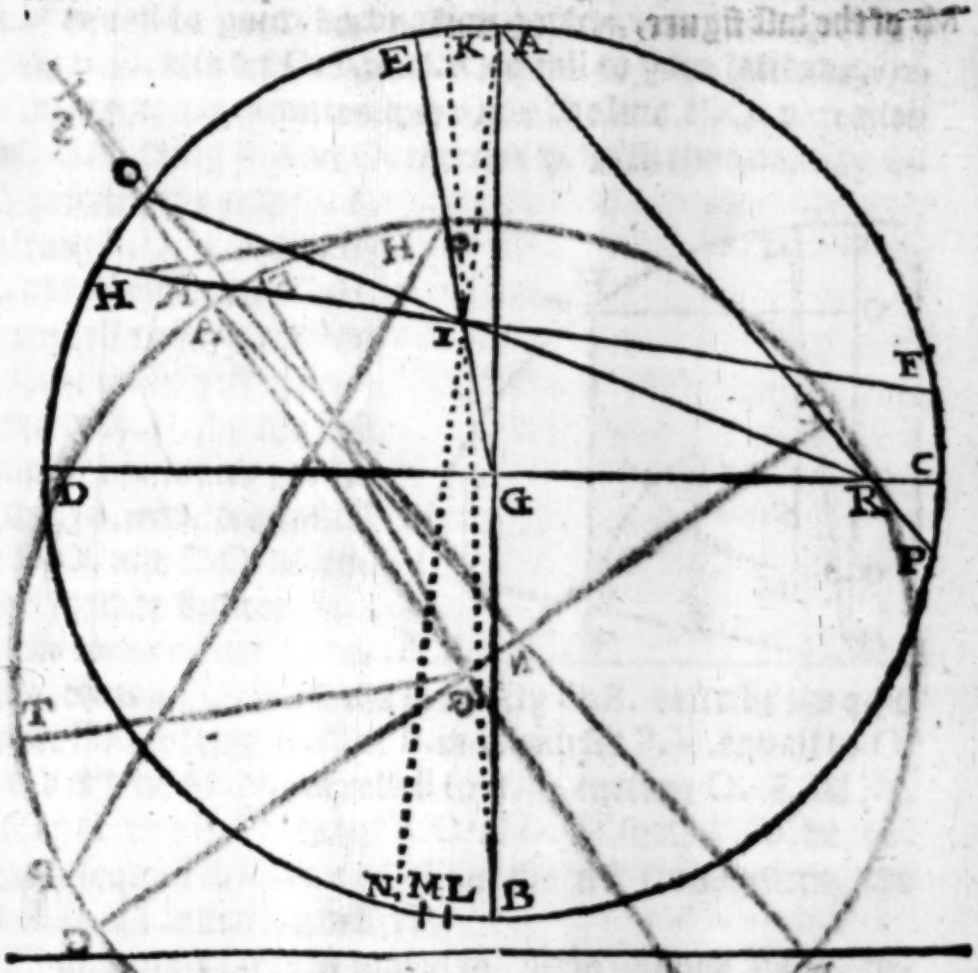
Hauing gotten, as before is taught, the Azimuth of the distance, then describe a circle, as G. F. H. I. which shall represent the Horizon circle, and draw the Dyametre G. C. H. which shal here represent your Horizontall line G. H. of the 12. chapter, then on C. erect C. F. perpendicular to G. H. so shall F. be the pole Zenith of that Horizontall line G. H. Now because the Horizontall distance of the ☉ from F. the pole Zenith of the wall, was found, as is said, 91. degrees Eastwards, therefore I set B in F. H. 91. degrees from F. so that at B. was the place of the Sunne at that instant, and because the Azimuth of the Sunne was found east-wards from the South point, or rather it is better to say the south point of the Horizō, viz. D. was found 102. degrees west-wards from ☉ then being at B. therefore set D 102. degrees westwards, from B towards G. and so at last it appeareth plainely that the Arch D. F of the Horizon, comprehended betweene the South point D. and the pole Zenith of the wall F. must needes be the declination sought, which by the first chapter you shall finde to bee eleuen degrees, as before.

CHAP. 16.

The declination of any vpright wall giuen, how thereby to get the cockes height of his deflection from the plum line, by a new conceit of the Author.

DEscribe a circle, as A. C. B. D. and quarter him square with two Dyametres A. G. B. and C. G. D. then set A. E. in A. D. and C. F. in C. A. each equall to the declination of your wall gotten in the last Chapter, viz. 11. degrees, and set E. H. in E. D. equall to the latitude of the place where the Dyall is to be made, viz. 51. degrees, 40. minutes our latitude at Reading. Then draw G. E. and also F. H. cutting G. E. at I. Then extend the line B. I. cutting

ting A. D. at K. and also A. I. cutting B. D. at N. then set B. L. in B. N. equall to A. K. then diuide L. N. in halfe at M. and set C. P. in C. B. equall to B. M. and extend A. P. cutting C. B. at R. Lastly, extend the line R. I. to cut A. D. at O. So shall B. M. or C. P. equall to it, be the deflection, which by the first chapter you shall finde to bee 19. degrees 40. minutes, and D. O. shall bee the cockes eleuation, which by the 1. Chapter you shall finde to be 37. degrees 30. minutes.

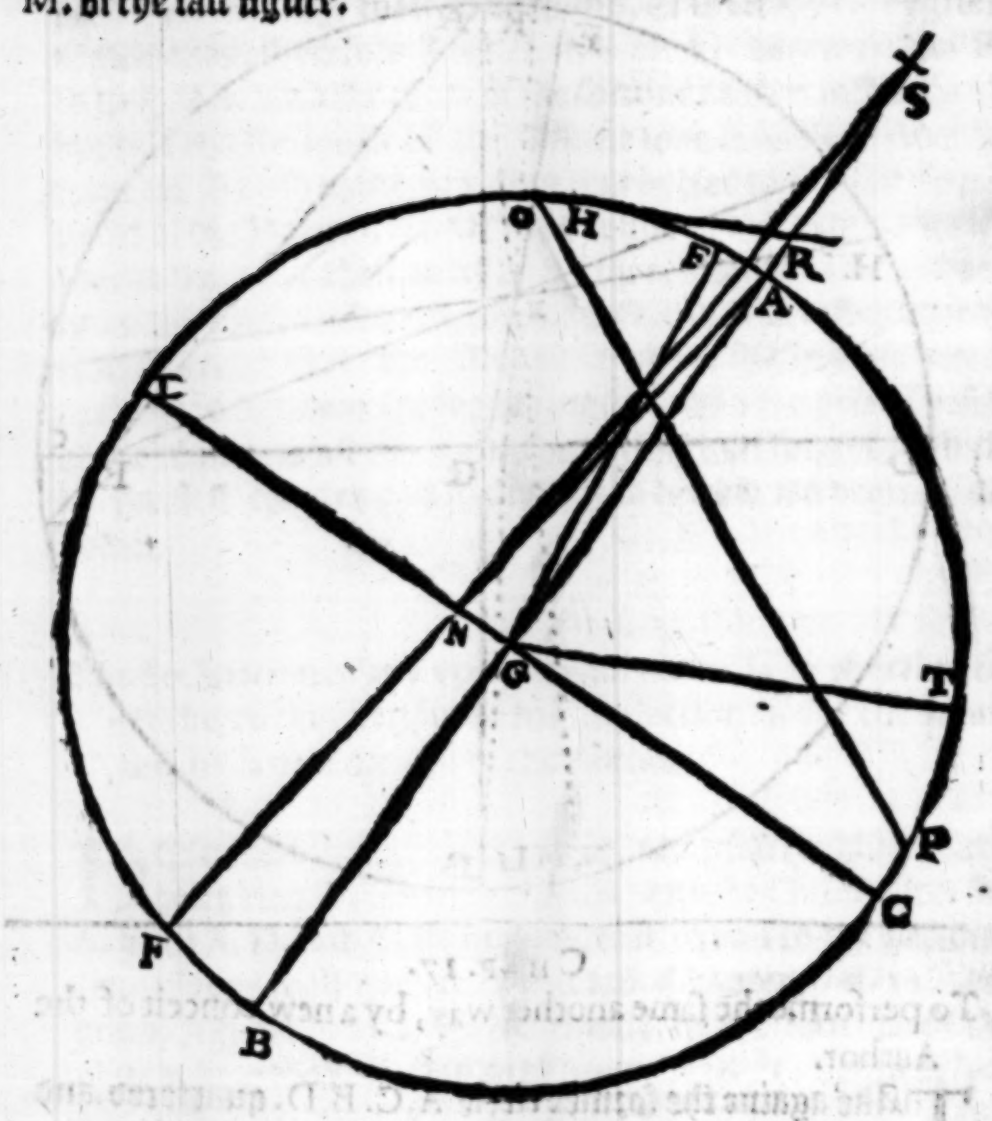


Chap. 17.

To performe the same another way, by a new conceit of the Author.

TAke againe the former circle A. C. B. D. quartered, and set B. F. in B. C. equall to the walles declination, viz.

11. degrées. & set C.H. in C.A. & A.T. in A.D. each equall to your latitude, viz. 51. degrées, 40. minutes, and draw G. T. then draw the line A.F. crossing C.D. at N. then extend H.R. parrallell to G.T. cutting G.A. extended at R. then set R.S. in G.R. extended equall to R.H, then draw the line S.N. then take R.H. in your compasse, and therewith from R. cut off the line S.N. at I. then extend G.I. to cut A.C. at E. I say now that E.G.A. is the angle of declination sought, viz. 9. degrées: for A.E. is equall to C. or B.M. of the last figure.



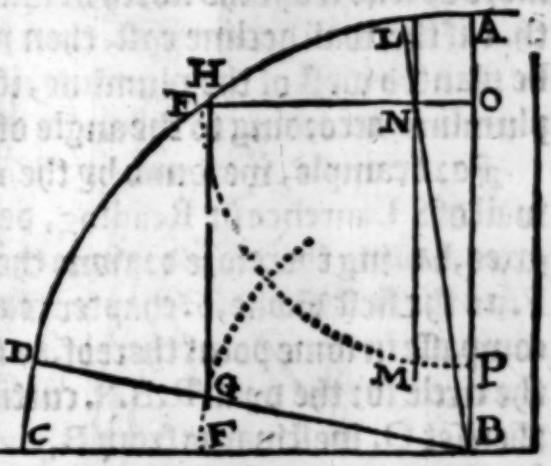
Lastly

Lastly set D. P. in D. A. equall to A. E. and extend P. I. to cut A. C. at O. I say againe, that E. O. shall be the elevation of the cocke desired, equall to D. O. of the last figure. viz. 37. degrees, 30. minutes.

Chap. 18.

To performe the same a third way more common.

Describe a quadrant, as A. B. C, then set C. D. in C. A equall to your declination gotten, viz. 11. degrees, & draw B. D. also set C. E. in C. A. equall to your latitude, viz. 51. degrees, 40. minutes, and draw the line E. O. parrallell to B. C. cutting B. A. at O. then on B. with the quantity O. E. describe the arch G. F. cutting B. D. at G, and B. C. at F. then extend G. H. parrallell to B. A. cutting A. C. at H. so shall the degrees of A. H. by the first chapter bee found 37. degrees, 30. minutes equall to D. O. and E. O. of the two former figures, and is the cocks elevation desired, then on O. with the quantity O. E. describe the quadrant P. E. cutting B. A. at P. in which set P. M. equall to G. F. and extend M. N. parrallell to B. A. cutting O. E. at N. Lastly extend B. N. to cut A. C. at L. so shall A. L. be 90. degrees equall to E. A. or C. F. of the last two figures, the same is the deflection desired.



Thus haue I set three waies to performe one thing, because a learner not well grounded in Arts, may by 3. tryals know when he hath done well, and sometimes one may fit the question better then the other. I could yet trouble our Dyagrammaticianes, with one way or two more, but these may suffice.

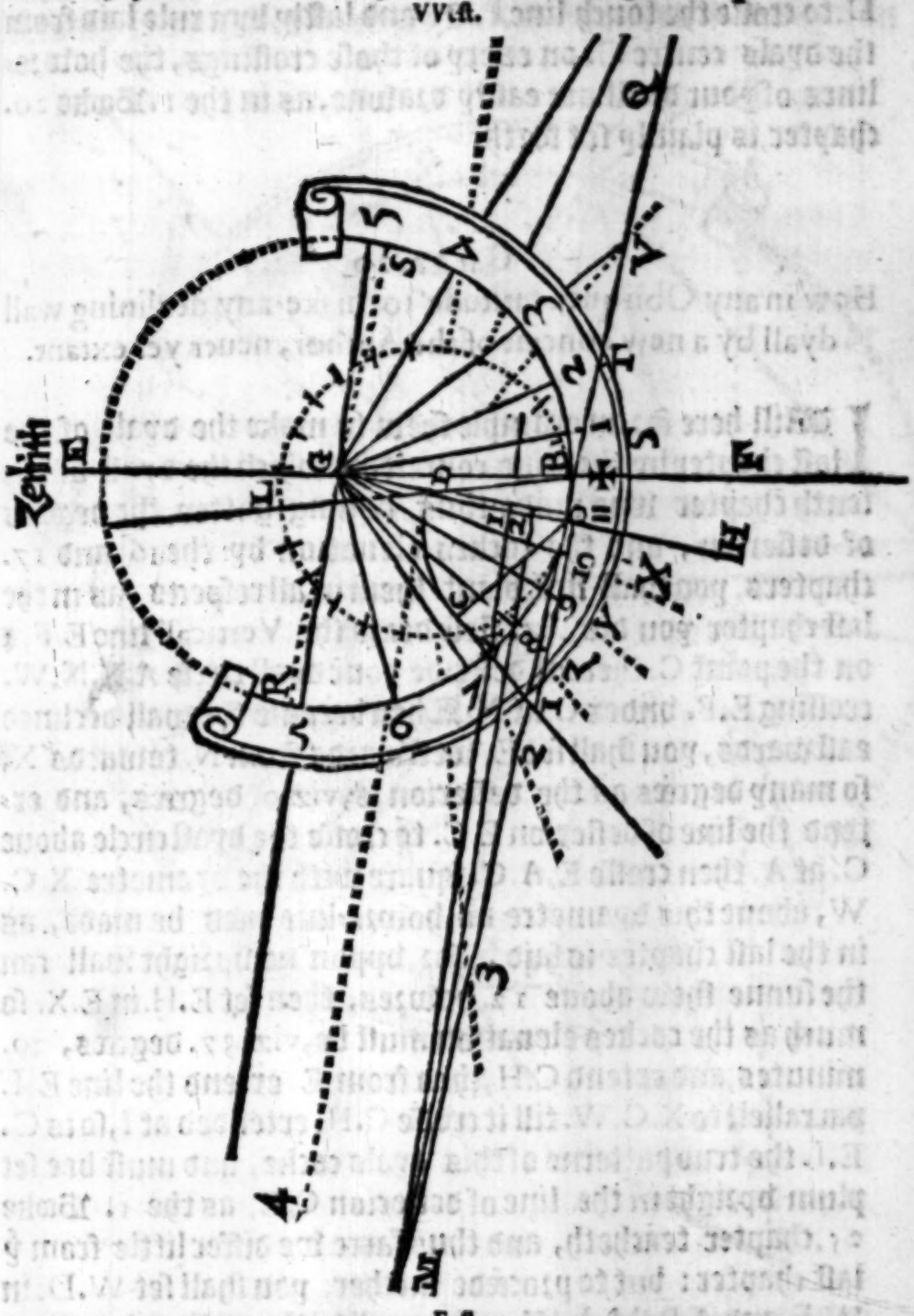
CHAP. 19.

How for any declining wall dyall, in any oblique latitude to plant the line of deflexion artificially, and thereby to make the dyall, as the first Booke 20. chapter teacheth.

IT is said in the first Booke, that the Verticall or plumline of any wall, is the Horizontall Meridian, because on all vpright walles, the east and west excepted, it limiteth 12. of the clocke and that the line of deflerion is the Meridian of the wall, because in it the cocke or Gnomon must be seated. This line of deflerion in declining walles, declineth from the plum line more or lesse, according as the wall declineth more or lesse from the north or south vpon these conditions, that if the wall decline east, then must the line of deflerion be planted west of the plumline, if west, then east from the plumline, according to the angle of deflerion.

For example, we found by the 16. chapter, ỹ the Church wall of S. Laurence in Reading, declined eastwards 11. degrees, hauing therefore drawne thereon the Verticall line E. F. as the first Booke, 6. chapter teacheth, then pitching my compasse in some point thereof, as G, and thereon describing the circle for the dyall R. B. S. cutting G. F. vnder G. at B. I then set O. westwards from B, viz. towards R. so much as by the 16. or 17. chapters, the angle of deflerion came vnto viz. 9. degrees, and then draw the line of deflerion G. O. cutting the dyall circle at O. in which line the cocke must stand, then thorough O. draw the line P. O. Q. square, crossing G. O. the same is your touchline, and crosseth the Verticall line E. F. at H. then thraw G. draw a dyametre to your dyall circle, viz. R. G. S. parrallell to P. Q. for aboue that dyametre seldome any howre lines are in vse, then set O. A. in O. R. equall to your cockes eleuacion gotten by the 16. and 17. chapters, viz. 37. degrees, 30. minutes, and extend G. A. to cut P. Q. at I. so is G. O. I. the true patterne for the cocke of this dyall, then from O. extend your compasse to touch

touch G.I. at C, and therewith make O.D. in O.G. equall to O.C, then on O.D. with D.O describe your Equinoctiall



A Southwall dyall declini eastwardes 11 degrees, his a gle of deflexi O.G. B. 9. grees, the coc eleuation. degrees 30. nutes viz. l. O.

circle, L.M.O.N. then extend the line H.D.L. diuiding your Equinoctiall circle in two halfes, then diuide each halfe into

into 12 equall parts, by euery of which parts, or at least & so many as you shall neede extend radiall lines issuing from D. to crosse the touch line P.Q, and lastly by a rule laid from the dyals centre G. on euery of those crossings, the howre-lines of your dyall are easily drawne, as in the 1. Booke 20. chapter, is plainly set forth.

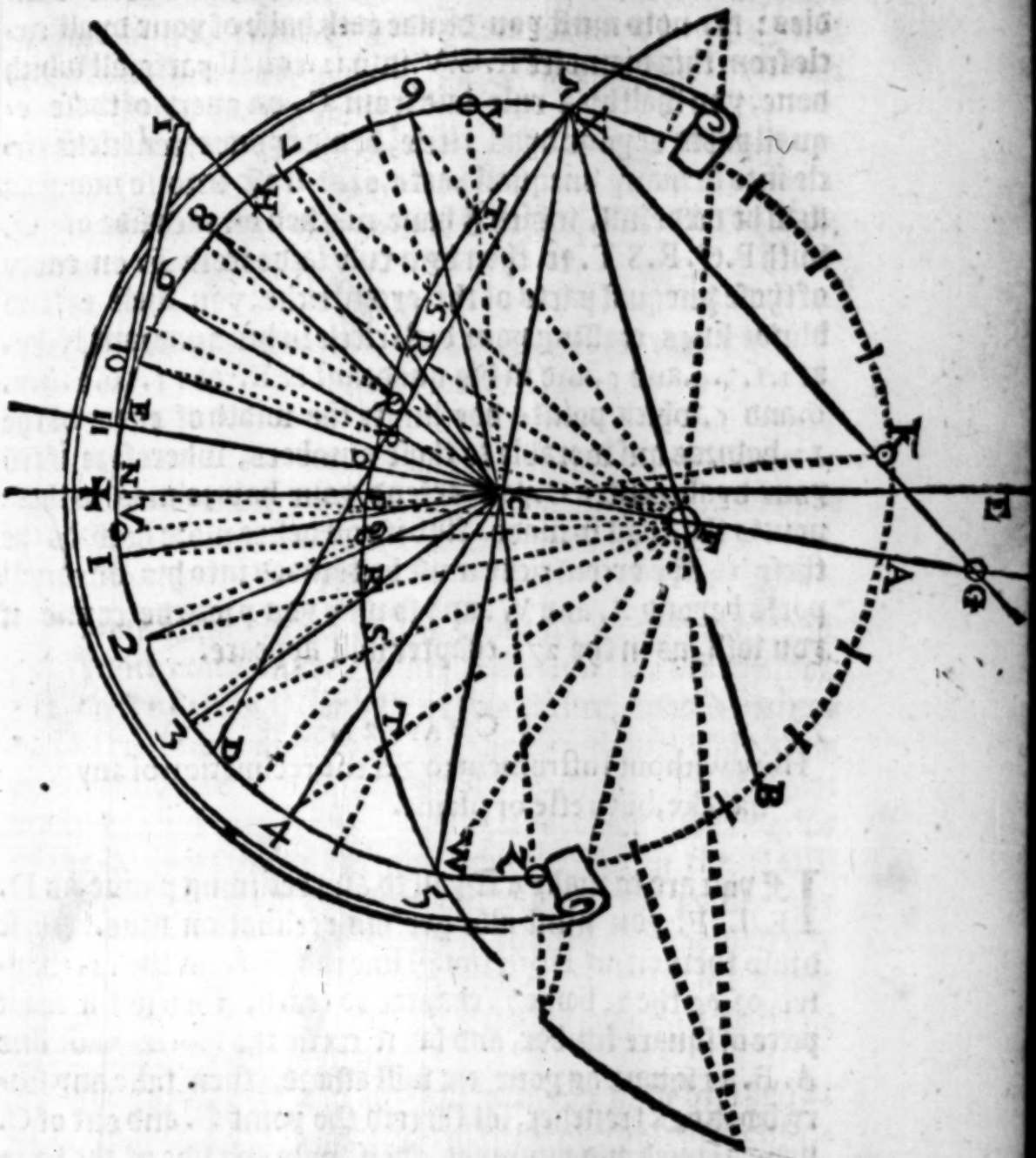
CHAP. 20

How in any Oblique latitude to make any declining wall dyall by a new conceit of the Author, neuer yet extant.

I Will here for an example shew to make the dyall of the last chapter by the same conceit, by which the dyall of the tenth chapter was made thus, hauing gotten the degrees of declerion, and the cockes eleuation by the 16. and 17. chapters, you shall first plant them in all respects, as in the last chapter you did, viz. first draw the Verticall line E.F, & on the point C. thereof, describe your dyall circle A.X.N.W. crossing E.F. vnder C. at N. Then because the wall declined eastwards, you shall set E. westwards from N. towards X, so many degrees as the declerion is, viz. 9. degrees, and extend the line of declerion E.C. to crosse the dyall circle aboue C. at A, then crosse E.A.C. square with the dyametre X.C.W, aboue this dyametre no howre-line need be made, as in the last chapter is said, for vppon no vpright wall can the sunne shew aboue 12. howres, then set E.H. in E.X. so much as the cockes eleuation must be, viz. 37. degrees, 30. minutes, and extend C.H, then from E extend the line E.I. parrallell to X.C.W. till it crosse C.H. extended at I, so is C.E.I. the true patterne of this dyals cocke, and must bee set plum vpright in the line of declerion C.E, as the 1. Booke 25. chapter teacheth, and thus farre we differ little from ỹ last chapter: but to proceede further, you shall set W.D. in W.E, and A.B. M.A.W. each equall to the cockes eleuation, viz. 37. degrees, 30. minutes equall to E.H, then extend X.

D.

D. crossing C.E. at O. and X.B. crossing C.A. at F. then extend X.G. to crosse C.A. extended, if neede be at G. so that it make with X.B. the angle G.X.B. equall to B.X.W, then



on G. with G.X. or G.W. describe an excontricke arch X.O. W, which shall exactly crosse ỹ point O. if you haue wrought

well, then draw F.N. which shall crosse the arch X.O.W. at P. Then laying a rule on C. and P. draw the diametre K.C. P.V. which I call the prime dyametre, and to know him the better, marke his two ends K. and V. with two little rundles: for now must you diuide each halfe of your dyall circle from this diametre K.C.V. into 12. equall parts, all which done, you shall by a rule laid from C, on euery of those equall parts of your dyall circle, deuide your excentricke circle into so many vnequall parts, or at least into so many as shall be nædefull, which I haue marked on each side of O. with P.Q.R.S.T. &c. then by a rule laide from F. on euery of those vnequal parts of the excentricks, you shall extend blinde lines, crossing your diall circle in his quadrant N.W. at 1.2.3.4. and 5, and in his quadrant N.X. at 11.10.9.8.7. 6. and 5. which points doe limite the width of euery of the 12. howres answerable to those numbers, wherefore if frō your dyals centre C. you extend your howre lines to those points the dyall is made. And if you desire more howres thē these 12. the excentricke must be deuided into his vnequall parts beyond X. and W. and so may you proceede round if you will, as in the 27. chapter will appeare.

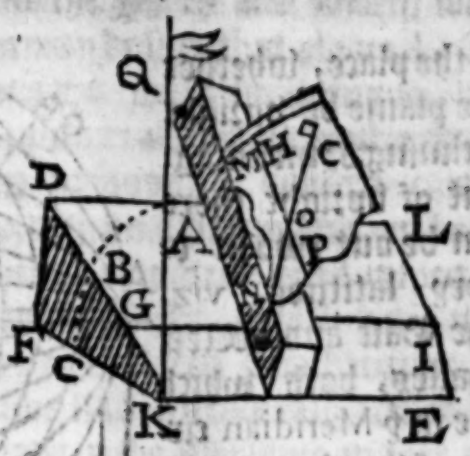
CHAP. 21.

How without Instrument to get the reclination of any bancke, buttresse or plaine.

IF you are to make a Dyall to any reclining plaine, as D. E. L. F. you must also get his reclination thus. First draw thereon an Horizontall line, as G. I. as the 11. chapter, or as the 1. booke 7. chapter do teach, then get a short peece of square timber, and lay it crosse the Horizontall line A. B. as square as your eie will afford, then take any sorry bord or a trencher, set therein the point C. and out of C. hang a thred and plummet, then apply one side of the bord to the one edge of the timber peece, that the plummet may hang at liberty by it, and marke two points towards each

end

end of the bowde where it toucheth the timber peece, viz. M. and N. and withall marke some point as O. vnder the threede so hanging. then carry home your bowd, with those points, C. M. N. and O. so marked, and with your rule and compasse, drawe H. O. P. parrallell to M. N. and drawe C. O. so shall the angle H. O. C. be the angle of reclination sought, viz. equall to the angle D. K. Q.

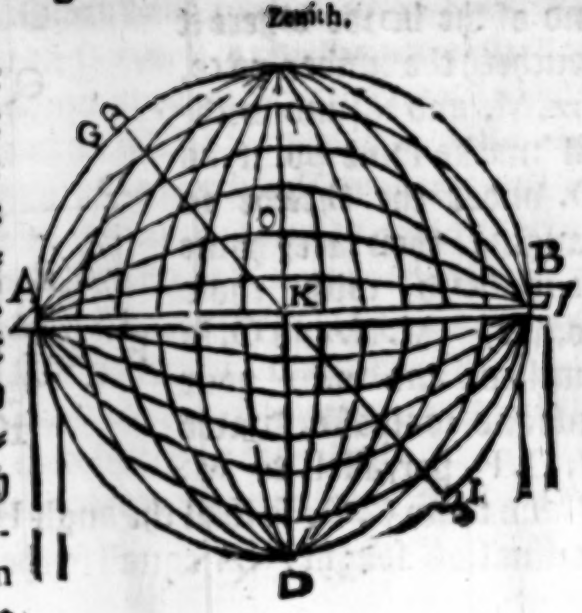


Chap. 22.

Of position plaines, what they are, and how their angles of deflection, and cockes elevation are obtained.

Those great circles of the Spheare in any Latitude, which crosse on the Zenith and Nadir points thereof, viz. on the points C. and D. of this figure, whose plaines doe all crosse one another, also on the Zenith line C. D. they are called Azimuthes, and in the plaine of some one of them euery vpright wall lyeth. And againe, those great circles of the Spheare in any latitude, which crosse on the North and South points of the Horizon, viz. on the points A. & B. of the Meridian line A. B. whose plaines also doe all crosse one another on the Meridian line A. B. they are called circles of Position, and therfore I call such plaines as lye in any of them, Position plaines.

When as therefore in any latitude you finde by the 14. or 15. chapters, the declination of the Horizontall line of any reclining or inclining plaine, iust 90. degrees, then be sure that plaine lieth in one or other of those circles of Position, and that Horizontall line is all one with the Meridian line



of the place, whether the plaine be vpright reclining or inclining: but of vpright there can be but two in euery latitude, viz. the East and West walles, both which lye in ỳ Meridian circle of the place, which is ỳ 90. circle of Position: for the Horizon circle it selfe is the first.

Nadir.

For better explanation by this figure, A. K. B. is our Horizon circle, and C. D. our Zenith line, on which our Azimuthes do all crosse, and A. B. is our Meridian line, on which our circles of Position do all crosse, and the North pole G. is elevated with vs aboue A, the North point 51. degrees, 40. minutes, but now if you will trauell round the spheare till C. K. D. become the Horizon circle, as in some part of America it will so happen, then shall C. D. become your Meridian line, and A. B. your Zenith line, and your former circles of Position shall now become Azimuthes, and there you shall finde the South pole H. elevated aboue D. the South point of that Horizon, 38. degrees 20. minutes: for D. H. equall to G. C. shall be the complement of A. G.

Admit therefore in our latitude of 51. degrees 40. minutes that a plaine be proposed declining 90. degrees, and reclining 60. degrees, from the Zenith C. towards the east, as A. O. B. he shall be therefore but 30. degrees aboue the Horizon circle A. K. B. now in that South latitude, where A. B. representeth the Zenith line, and A. K. B. the vertical

or

or east circle, (in whose plaine the North and South wall of euery latitude doe lye) you may be sure that plaine A. O. B. doth there represent an vpright wall, declining 30. degrees from the plaine of the South wall A K.B. westwards: and therefore you shall by the latitude 38. degrees 20 minutes, and the declination 30. degrees Westwards, get both the angle of deflection, and cockes eleuation in all respects, as in the 16. 17. or 18. chapters is taught, which had, the angle of deflection must with vs be placed Northwards, & still vnderneath the Meridian or line Horizontall, which so planted, the Dyall is to be made in the selfe same maner, as before in the 19. and 20. chapters is taught without alteration.

Chap. 23.

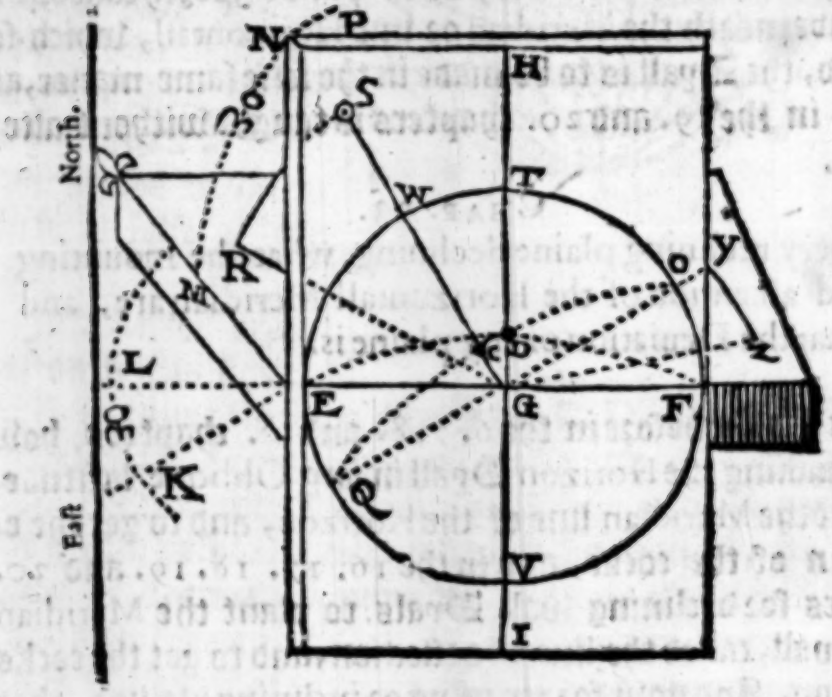
In euery reclining plaine declining, what the mounting and ascention of the Horizontall Meridian are, and what the Deuiation of any plaine is.

IT is taught before in the 6. 7. 8. and 10. chapters, how for making the Horizon Dyall in any Oblique latitude, to plant the Meridian line of the Horizon, and to get the eleuation of the cocke, and in the 16. 17. 18. 19. and 20. chapters for declining wall Dyals, to plant the Meridian of the wall, called the line of deflection, and to get the cocks eleuation. And now for reclining or inclining plaines, that decline, we must teach to plant both the Meridian of the Horizon, which we therefore call the Horizontall Meridian: for it is he that giueth 12. of clocke in al Dyals whatsoeuer: also the Meridian of the plaine, which we call the line of deflection: for in him the cocke must alwaies stand, and also the cocks eleuation aboue the same: al which 2. hauing by the 14. and 15. chapters, gotten the declination, and by the 21. the reclination or inclination, we shal here following teach most artificially to get, and so make the Dyals to those as easily as any other, although Andreas Sconerus and others, make a wilderneſſe of lines, before they can make one of

these

these Dyals, and diuers other Authors, as Munster and Orontius and others, leaue them quite out rather then to be troubled with them.

Let A. B. be a square Horizontall plaine, viz. set leuell with our Horizon here at Reading, and so that his one side E. A. lye iust North and South. Let there also be ŷ plaine N. X. eleuated 30. degrees aboue that plaine, A. B. viz. according to the Arch M. N. and therefore reclining from the



Zenith line E. P. Northwards 60. degrees, according to the arch N. P. which plaine N. X. let it also decline from ŷ south westwards, according to the arch L. K. viz. 30. degrees, then on this plaine N. X. draw the Horizontal line E. F. by the 11. chapter, and his line of reclination H. G. I. by the 1. Booke 7. chap. crossing E. F. square at G. with G. E. describe ŷ circle T. E. V. F. crossing H. I. at T. and V, then by the 1. Booke, 19. chapter, or by the 26. chapter following, admit the Horizontall Meridian G. S. to be planted, cutting T. E. at W. I say that the arch E. W. is that which we now call the Horizontall Meridians ascention, because G. S. is ascended aboue E. G. the

G. the Horizontall line of this plaine so many degrées, as E. W. commeth to, which is about 63. degrées 20. minutes, and now if from S. you let downe a perpendicular arch, as S. R. to the Horizontall plaine A. B. I say that arch S. R. which is about 26. degrées 30. minutes, we call here the mounting of the Horizontall Meridian aboue the Horizontall plaine A. B.

I shew. d in the 22. chapter, that the pole Zenith of a reclining or inclining plaine is one thing, which I may call the pole Zenith of the reclination or inclination, although it also be a kind of deuiation, viz. the point D. of the circle. E. D. F. eleuated aboue the Horizontall plaine, whereby D. is deuiated from the plaine of our Meridian circle, according to D. G. which is equall to the reclination P. N. and ỹ the pole Zenith of the Horizontall line is another thing, viz. the point G. of the Horizon circle, E. G. F. lying or declining in this example Westwards from the South point of the Meridian line of the place so much as the declination cõmeth to, viz. 30. degrées equal to L. X. but now ỹ which I call the pole Zenith of the deuiation of any plaine, whether vpright or inclining, is a third thing, & hath a relation to some one line, declining from ỹ Vertical line of an vpright plaine, or from the line of reclination or inclination, of a reclining or inclining plaine, but in Dyalling we onely respect that deuiation, which hath relation to the scituation of the Horizontall Meridian, drawe therefore the Dyameter Q. G. O. extended to Y. crossing square the Horizontall Meridian G. S. and from Y. let downe the perpendicular arch Y. Z. to the plaine A. B. which arch Y. Z. is also the mounting of G. Y. then let there be a circle, as Q. C. O. crossing square the plaine N. X. on Q. G. O. I say now that the point C. is the pole Zenith of the deuiation of that plaine N. X. in respect of the line G. S. that is to say, the plaine N. X. must be turned about on the axtree G. S. so much as the arch Y. Z. commeth to, before the pole Zenith C. shall come to our Meridian circle, in euery Oblique latitude, the east & West

walles are deuiating plaines, because their pole Zenith deuiateth from our Meridian circle 90. degrees about the axtree of the world, as in the first booke 23. chapter is said.

Note that in these plaines that recline but little from the Zenith Northwards, the south pole will be eleuated, as the next chapter and the 26. chapter will shew, and in such the Horizontall Meridian will lye vnder the Horizontall line, E. F. and therefore you must call it the Descention and Depression of the Meridian, and not the ascention and mounting, and so generally contrary plaines haue contrary qualities, as in the 26. chapter shall more plainely appeare.

CHAP. 24.

The reclination and declinatioon of any plaine giuen in a knowne latitude, how to get the mounting and ascention of the Horizontall Meridian; the position Latitude, the Position Deuiation, the angle of deflection, and cockes eleuation.

FOr example, in the reclining plaine N.X. of the last chapter, ẏ reclination P.N. is 60. degrees Northwards, from the Zenith line E. P. & his declination K.L. 30. degrees westwards from the South.

Describe therefore a Quadrant A. B. C. set A. D. in A. C. equall to the reclination, viz. 60. degrees, and C. E. in C. A. equall to the declination, viz. 30. degrees, which in this reclination falleth out to be all one with the point D. Then draw B. D. and draw E. F. parrallell to B. C. cutting B. A. at F. then set B. G. in B. D. equal to B. F and draw G. H. parrallell to B. C. cutting A. C. at H. I say that C. H. is the Position deuiation sought, which by the first chapter you shall finde 13. degrees 50. minutes.

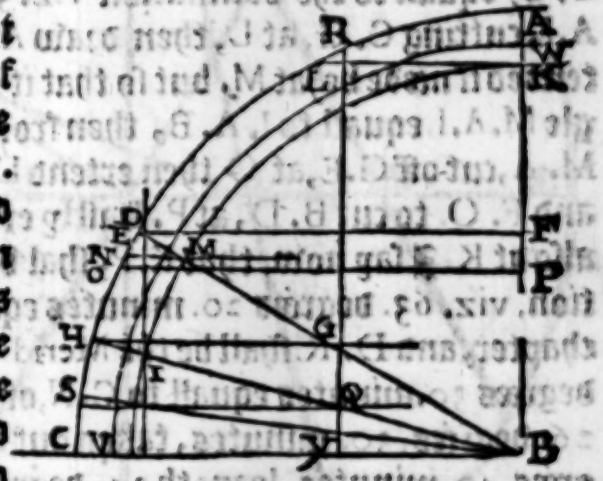
Then draw B. H. and ertend E. I. parralell to A. B. cutting B. H. at I, then on B. with B. I. describe the arch I. M. K. cutting B. A. at K. and B. D. at M. Lastly draw K. L. parrallel to B. C. cutting A. C. at L. I say C. L. shall be ẏ

Ascen-

Ascention sought, which by the 1. chapter you shall find 63. degrees, 20. minutes, viz. equall to E. W. of the last Chapter.

Then extend M.N. parrallell to B. C. cutting A. C. at N. I say C. N. shall be the mounting sought for, which by the first chapter you shall find 26. degrees, 30. minutes, equall to the arch R. S. of the last chapter, which 26. degrees 30. minutes taken out of our latitude, here at Reading, leaueth 25. degrees 10. minutes, the Position latitude sought, that is to say, the eleuation of the pole aboue that Horizontall Meridian G. S.

Here by the way, note that if the degrees of this Mounting C. N, had bene iust as much as the latitude, viz. 51. degrees, 40. minutes, then had neither pole bene eleuated aboue it, and it had bin an Equinoctial or right Horizon plaine, of which wee will speake more in the 26. and 27. chapters, but if it had happened greater then the latitude 51. degrees 40. minutes, then be sure the South pole had bene eleuated and not the north pole, and then must the Meridian G. W. S. of the last chapter haue bene planted vnder the Horizon, line E. G. E. and the ascention before shal be the descention, as in the 26. chapter, shall more largely be shewed.



Then by the first chapter, set C. O in C. A equal to your Position latitude, viz. 25. degrees 10. minutes, and draw O. P. parrallel to B. C, cutting B. A at P, then set B. Q. in B. H. equal to B. P, then extend Y. Q. R, parrallel to B. A, cutting A. C at R. and B. C. at Y. I say A. R, shal be 24. degrees 10. minutes the rockes eleuation desired.

Then on B. with Y.R. describe the Quadrant W.V, cutting B.A, at W. and B. C. at V. then draw Q. T. parrallell to B. C, cutting W.V. at T then extend B.T. to cut A.C. at S. I say C. S, shall be fiue degrees, the angle of deflection sought for.

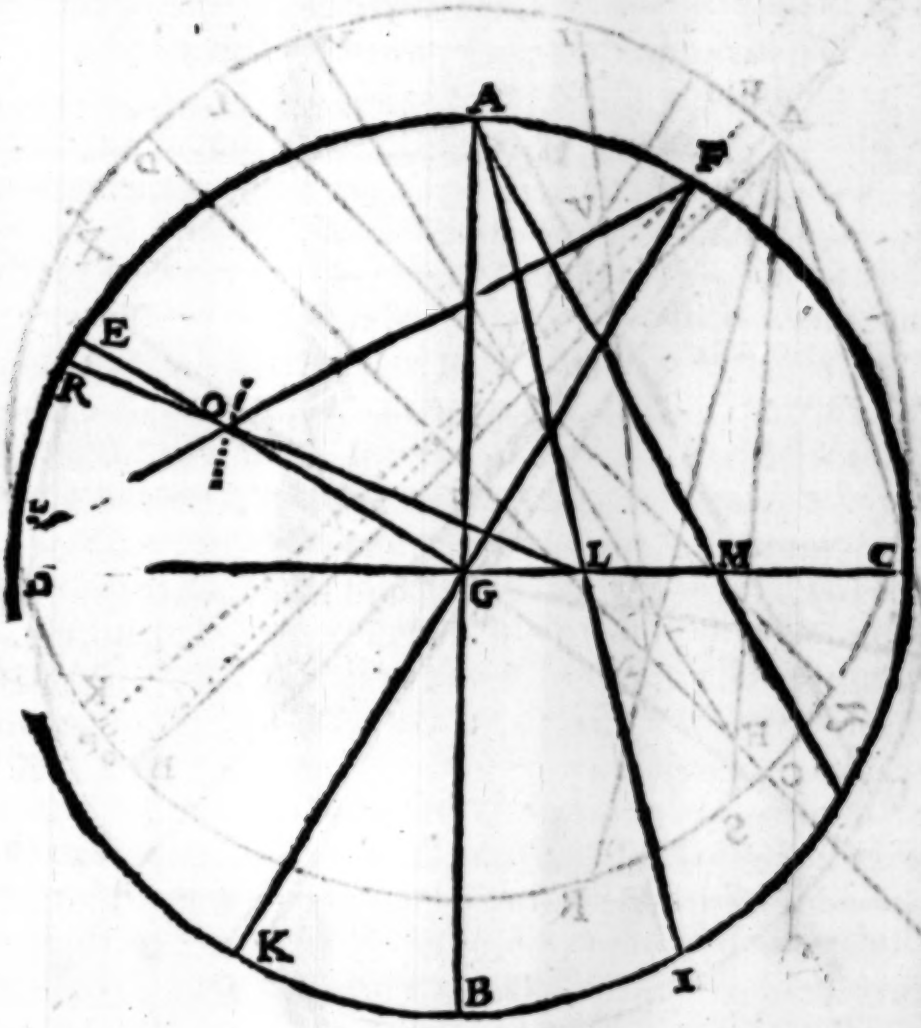
CHAP. 25.

To performe the same by a newer conceit of the Author.

DEscribe the circle A, B. C. D, on G, and quarter him square with two Diametres, A. G.B. and C. G. D, then set A.E, in E.D, and C. F, in C.A, each equall to the reclination, viz. 60. degrees, and draw G. E, Then set B. I, B. C, equall to the declination viz. 30. degrees, then draw A.f, cutting C. G, at L, then draw A. M, to cut G. C. (extended if neede be) at M, but so that it make with A. I, ỹ angle M.A.I equall to I. A. B, then from M. with the width M. A, cut off G.E, at O. then extend L.O, to cut A.D, at R. and F. O. to cut B. D, at P. Lastly extend F.G, to cut B.D, also at K. I say now, that K. P, shal be the Meridians ascention. viz. 63. degrees 20. minutes equall to C. L, of the last chapter, and D. R. shall be the Meridians mounting, viz. 26. degrees 30. minutes equall to C.N, of the last chapter, which 26 degrees, 30. minutes, taken out of the latitude 51. degrees 40. minutes, leaueth 25. degrees 10. minutes, the position latitude as before.

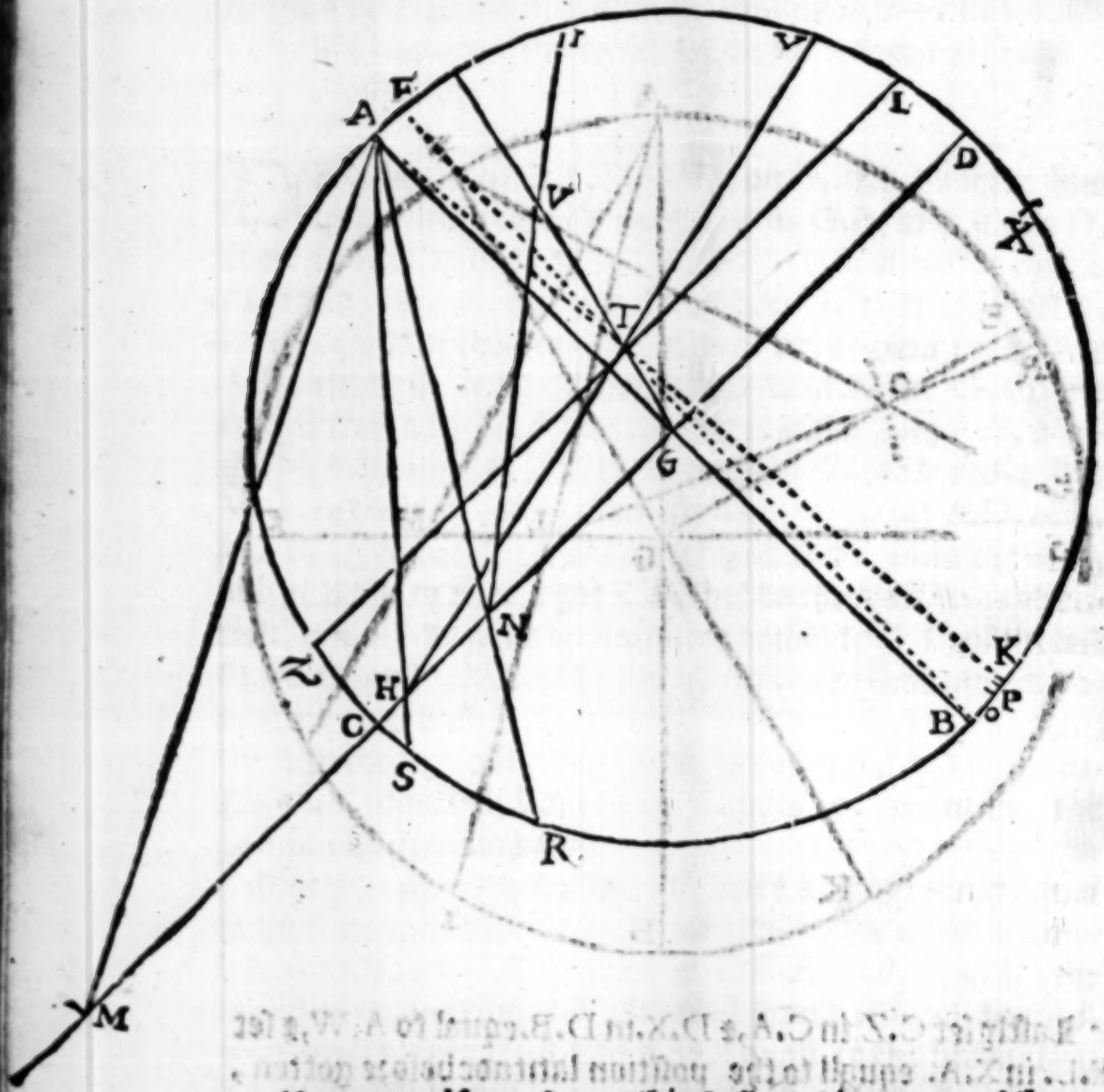
Then to proceede further, describe another circle equal to the forme, viz. A.C.B D. his centre G. his crosse diametres A.G.B, and C.G.D, then set C R. in C.B. equall to the Meridians mounting D.R of the last figure, viz. 26. degrees, 30. minutes, then set A.I, in A,D, equall to the declination B.I. of the last figure, viz. 30, degrees, then draw A,R, which shall cut G,C, at N, then draw N.I, thē draw A.M, to make with the line A.N, an angle M.A.N. equall to N,A,G, and cutting G,C, (extended if neede be) at M, then on M, with the

the width M, A, cut off the line N, I, at V, lastly extend G. V, to cut D, A, at W, I say y^t A. W, is the position deuiation desired equall to C, H, of the 24, chapter, viz. 13, degrees, 50, minutes.



Lastly set C. Z, in C. A, & D. X. in D. B. equal to A. W, & set X. L. in X. A. equall to the position latitude before gotten, viz. 25. degrees, 10. minutes, and draw Z. L, cutting G. W. at T, then extend A. T. to cut B. D. at K, and B. T. to cut A. D. at F, then set B. O. in B. K. equall to A. F, then diuide O.

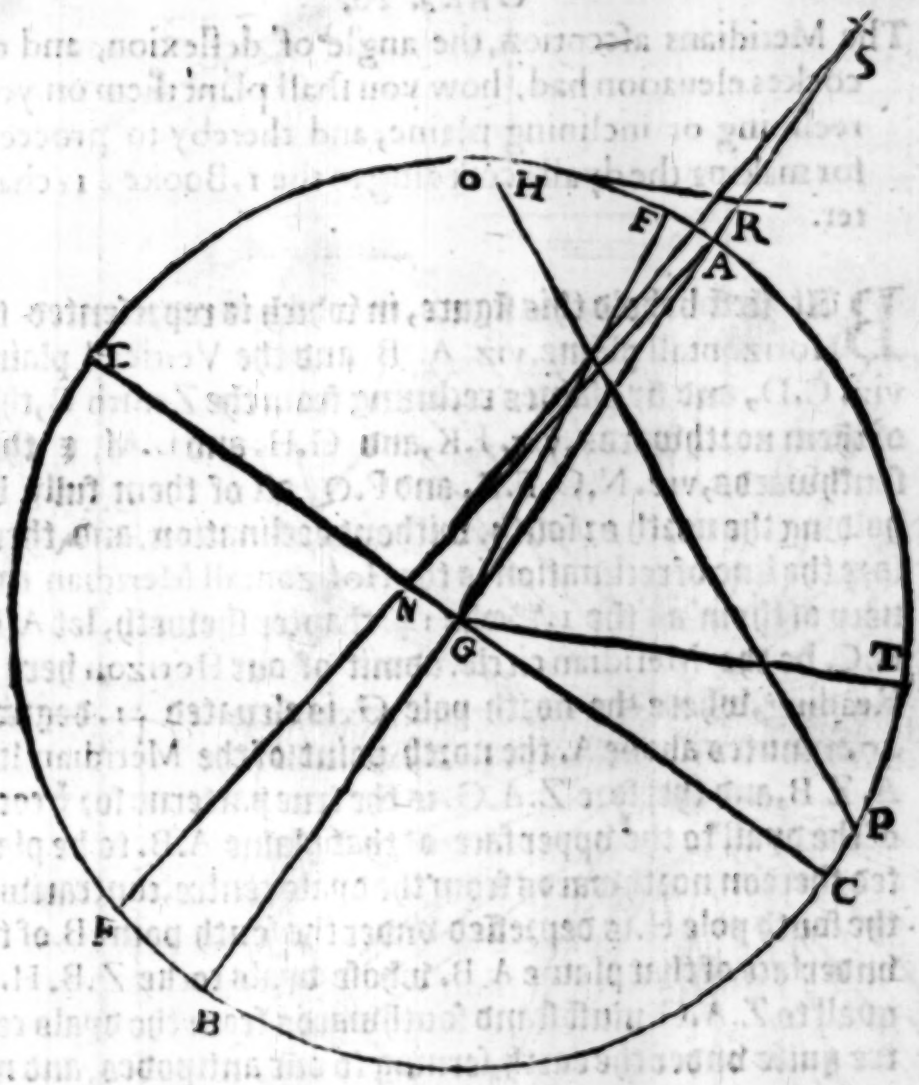
K. in halfe at P. I say B.P. is the declerion desired equall to C.S. of the 24. chapter, viz. 6. degrees, then set C.S. in C.B. equall to B.P, and draw A.S. cutting G.C. at H, then extend H.I. to cut D.A. at Y. I say that D.Y. is the cockes elevation sought, equall to A.R. of the 24. chapter, viz. 24. degrees 10. minutes.



You may also performe this last part in maner of the 17. chapter, thus, your circle A.B.C.D. deuided and quartered, set B.F. in B.D. equall to A. W. of the last figure, viz. 13.

de,

degrees, 50. minutes, and set A. H. in A. D, and C. T. in C. A. each equall to the position latitude before gotten, viz. 25. degrees, 10. minutes, and draw G. T, then draw A. F. cutting G. D. at N, then draw H. R. parrallell to G. T. cutting



G. A. ertended at R, then set R. S. in A. R. ertended equall to R. H, then draw S. N, then from R. with R. H. cut off S. N. at I, then ertend G. I. to cut A. C. at E. I say A. E. is the declination desired equall to B. P. of the last figure, viz. 6. degrees.

Then

Then set C.P. in C.A. equall to A.E, and extend P. I. to cut A.D. at O. I say that E.O. is the cockes eleuation desired equall to D.Y. of the last figure, viz. 24. degrees 10. minutes.

CHAP. 26.

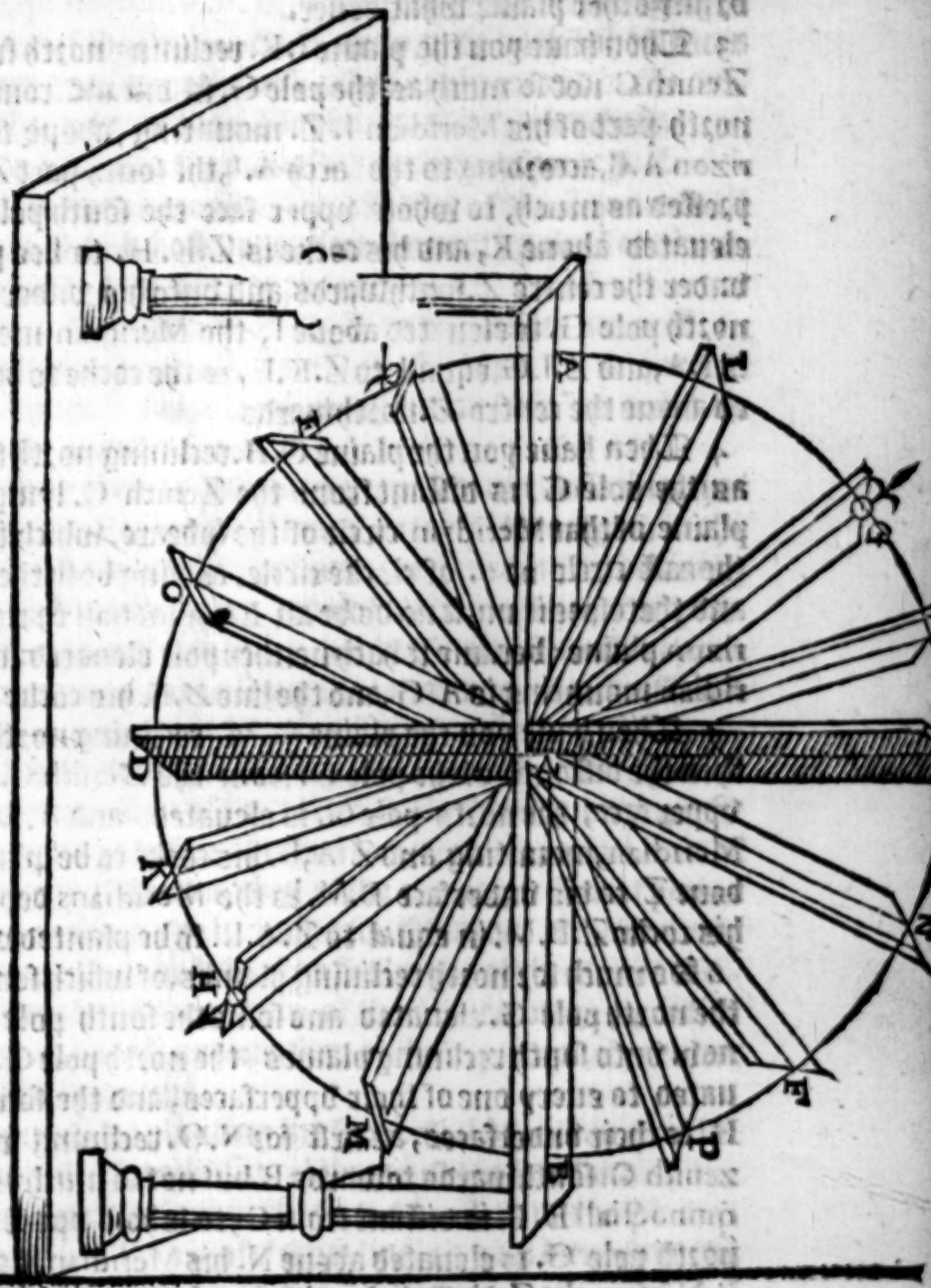
The Meridians ascention, the angle of deflexion, and the cockes eleuation had, how you shall plant them on your reclining or inclining plaine, and thereby to proceede for making the dyall according to the 1. Booke 21. chapter.

BVt first behold this figure, in which is represented the Horizontall plaine, viz. A. B and the Verticall plaine, viz. C.D, and six plaines reclining from the Zenith C, three of them northwards, viz. I.K, and G.H. and L.M, & three southwards, viz. N.O. E.E, and P.Q. all of them fully beholding the north or south, without declination, and therefore the line of reclination is the Horizontall Meridian in euery of them, as the 1. Booke 14. chapter sheweth, let A.D. B.C. be the Meridian circle, admit of our Horizon here at Reading, where the north pole G. is eleuated 51. degrees, 40. minutes aboue A. the north point of the Meridian line A. Z. B, and therfore Z.A.G. is the true patterne for ỳ cocke of the dyall to the vpper face of that plaine A.B. to be planted thereon northwards from the dyals centre, contrariwise the south pole H. is depressed vnder the south point B. of the vnderface of that plaine A. B. whose dyals cocke Z.B. H. equall to Z. A. G. must stand southwards from the dyals centre quite vnder the earth, seruing to our antipodes, and not to vs.

Then haue you the Verticall plaine C.D. perpendiculer erected on A.B pointing to the Zenith C. & Nadir D. whose face beholding the south B, representing the full south wall, hath the south pole H. eleuated aboue D, his cocke being Z.D.H. must be planted vnder the dyals centre towards ỳ south

south pole H but to his other face beholding the north, the

North. Horizon.



Nadir.

South pole.

South. wall plaine.

P pole

pole G. is eleuated aboue C. his cocke Z.C.G. must be plãted aboue the centre towards the north pole G. for ỹ point Z. doth here represent the centres of the dyals to all these, or any other plaine whatsoeuer.

3 Then haue you the plaine I.K. reclining north from the Zenith C not so much as the pole G. is distant from C, the north part of his Meridian I. Z. mounting aboue the Horizon A.B, according to the arch A.I, the south part Z.K. depressed as much, to whose vpper face the south pole H. is eleuated aboue K, and his cocke is Z.K.H. to bee planted vnder the centre Z. southwards and vnto his vnderface the north pole G. is eleuated aboue I, the Meridian mounting is I.A, and Z.I.G. equall to Z.K.H. is the cocke to be planted aboue the centre Z. northwards.

4 Then haue you the plaine G.H. reclining north so much as the pole G. is distant from the Zenith C. lying in the plaine of that Meridian circle of the spheare, which is called the east circle or 6. of clocke circle, cutting both the poles, and therefore it must néeds be an Equinoctiall or right Horizon plaine: because it hath neither pole eleuated, the Meridian mounting is A. G, and the line Z.F. his cocke.

5 Then haue you the plaine L.M. reclining north, more then the distance of the pole G. from the Zenith C. to his vpper face, the north pole G. is eleuated, and A. L. is his Meridian, mounting, and Z A, L. his cocke to be planted aboue Z. to his vnderface B.M. is the Meridians depression, his cocke Z.B.M. is equal to Z.A.L. to be planted vnder z.

6 So much for north reclining plaines, of which some haue the north pole G. eleuated and some the south pole H: But now vnto south reclining plaines, the north pole G. is eleuated to euery one of their vpperfaces, and the south pole H. to their vnderfaces, as first for N.O. reclining from the zenith C. southwards towards B. but not so much as the Equinoctiall E. F. is distant from C, to whose vpper face the north pole G. is eleuated aboue N. his Meridian mounting B.N. his cocke Z.N.G. to be planted aboue z, to his vnder-

face

face the south pole H, is elevated, his Meridian depression A. O. his cocke Z.A.O. to be planted vnder Z.

7 Then haue you the plaine E. F. reclining south so much as the Equinoctiall E.F. is distant from the zenith lying in the plaine of the Equinoctiall circle, vnto both whose faces the polare dyall serueth with a stile or pin erected in the centre for the cocke, as the 1. Booke 15. chapter teacheth.

8 Then haue you the plain P.Q. reclining from the Zenith C. southwards, more then the distance of the Equinoctiall E.F. from C, to whose vpper face the north pole G is elevated aboue Q. according to the arch Q.G. his Meridian depression A. Q. his cocke Z. Q.G. to be planted vnder Z. to his vnderface the south pole H. is elevated, or rather depressed vnder P. his Meridian assention B.P. his cocke Z. P.H. to be planted aboue Z.

9 All these plaines before are proposed, not declining, that is to say, the Horizontall line of euery of them lyeth in the east line of the latitude: but now for reclining or inclining plaines that decline, viz. whose Horizontall lines wry aside from the east line, they haue also the selfe same accidents, according to the seuerall mountings or depressions of their Meridians, that is to say, if they recline northwards, and that their mounting or depression be lesse then the elevation or depression of the artræ G.H. they haue the quality of ỹ 5. precept before: if equal to artræs elevation, then of the 4. precept, if greater, then of the 3. precept. And of plains declining, reclining or inclining southwards, if their mounting or depression be lesse then the height of the Equinoctiall E.F. they haue the quality of the 8. precept, if equall to the Equinoctiall elevation, then of the 7. precept, if greater, then of the 8. precept.

10 So much for planting the Horizõtal Meridian, & cocks elevation of all reclining plaines: Now for planting the line of declerion, which is the true Meridian of the plaine, the other is but the 12. of clocke line, as hath beene said, if it be a north reclining plaine, and doe decline westwards, ha-

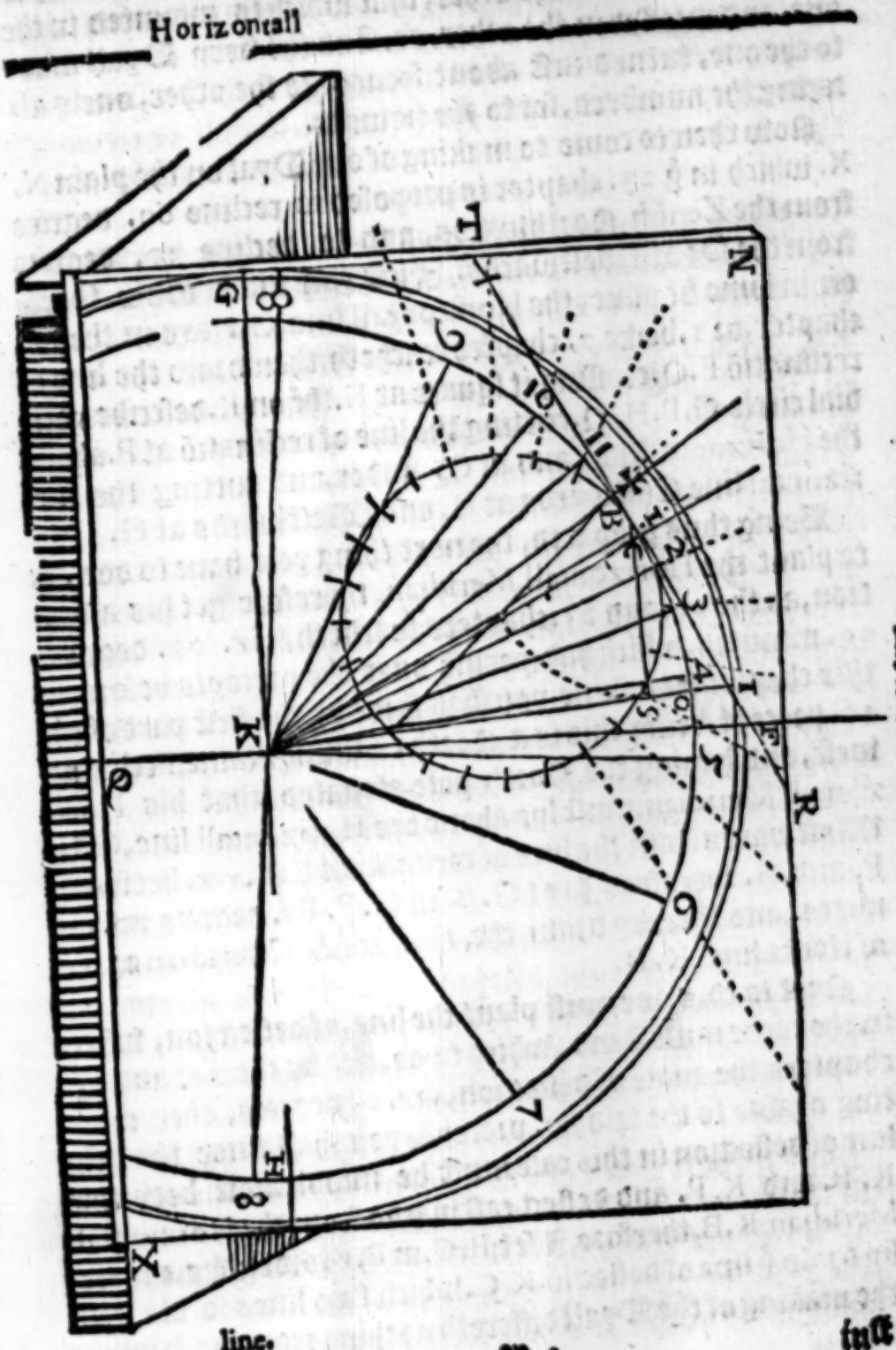
uing the north pole eleuated, the Horizontall Meridian shal ascend aboue the Horizontall line, and lye westwards from the line of reclination, and the line of deflerion shall ly eastwards from the Horizon Meridian, and so shall the line of deflerion be middlemost: but if the south pole be eleuated, then shall the Horizon Meridian descend vnder the Horizon line, and lye eastwards from the line of reclination, and the line of deflerion eastwards from it, so that the Horizontall Meridian shall be middlemost: but if neither pole be eleuated, then be sure that reclining plaine, is a right Horizon.

And if it be a north reclining plaine declining eastwards, hauing the north pole eleuated, the Horizontall Meridian shall ascend aboue the Horizontall line, and lye eastwards from the line of reclination & the line of deflerion betwéne them: but if the south pole be eleuated, then the Horizontall Meridian shall descend vnder the Horizontall line, and lye westwards from the line of reclination, and be middlemost, as before, but if neither pole be eleuated, viz. that the mounting be equall to the latitude, then be sure euer that is a right Horizon plaine, of which sort euery declination hath onely one and no more, and also one polare Horizon.

Then for south reclining plaines, declining west, the Horizontall Meridian shall ascend aboue the Horizontall line, and lye eastwards from the line of reclination, and ỹ line of deflerion westwards from the line of reclination, so that the line of reclination is there middlemost, vntill the mounting of the Meridian be equall to the latitude, and thē it lyeth in the plaine of the Equinoctiall E.F, and becom a polare Horizon, as is said, but after that height the *Horizon* Meridian is still depressed vnder the *Horizon* line, and lyeth westwards from the line of reclination, and the line of deflerion westwards from it, so that the *Horizontall* Meridian is middlemost, euen vntill the reclination come vp to the zenith.

And generally séeing all inclining plaines are but the vnder

verfaces of reclining plaines, therefore their accidents are



line. inft

iuſt contrary: for what is North or Weſt in the one, is South and Eaſt in the other, that which is mounted in the one, is depreſſed in the other, &c. And the very Dyall made to the one, turned iuſt about, ſerueth to the other, onely altering the numbers, ſet to the howers.

Now then to come to making of our Dyal on the plain N. X. which in ℣ 23. chapter is propoſed to recline 60. degrées from the Zenith Northwards, and to decline 30. degrées from the South weſtwards. Firſt you muſt draw thereon in ſome fit place, the Horizontall line, G.H. as in the 11. chapter, or 1. booke 7. chapter teacheth, then draw the line of reclinatiõ F.Q. croſſing it ſquare at K. thẽ on K. deſcribe your dial circle G.P.H.Q. cutting the line of reclinatiõ at P. aboue the Horizontal line, and at Q. vnder, and cutting the Horizontal line Eaſtwards at H. and Weſtwards at G.

Being thus prepared, the nert thing you haue to doe, is to plant the Horizontall Meridian, therefore get his aſcention, as the 24. and 25. chapters teacheth, viz. 63. degrées, 20. minutes, which had, peruſe ouer the precepts before, in this chapter ſet downe, you ſhall finde by the firſt part of the 10. precept, being this is a North reclining plaine, declining weſt, and hauing the North pole eleuated, that his Horizontall Meridian, muſt lye aboue the Horizontall line, G.H. Weſtwards from the line of reclination K.F. viz. betwæne P. and G. therefore I ſet G.B. in G.P. 63. degrées 20. minutes, and thereby draw the Horizontall Meridian or 12. of clocke line, K.B.

Nert to this, we muſt plant the line of deflection, where in the cocke muſt ſtand, which to do, get by the 24. and 25. chapters the angle of deflection, viz. 6. degrées, then reſorting againe to the ſaid 10. precept, you ſhall finde that the line of deflection in this caſe muſt be middlemoſt betwæne K.B. and K.P. and deflect eaſtwards from the Horizontall Meridian K.B. therfore I ſet B.C. in B.P. 6. degrées, & thereby draw ℣ line of deflectiõ K.C. which two lines ſo planted, the making of the Dyall differeth nothing from the forme of

declining

declining Dyals taught in the 19. chapter, which this figure may teach better then many words.

Chap. 27.

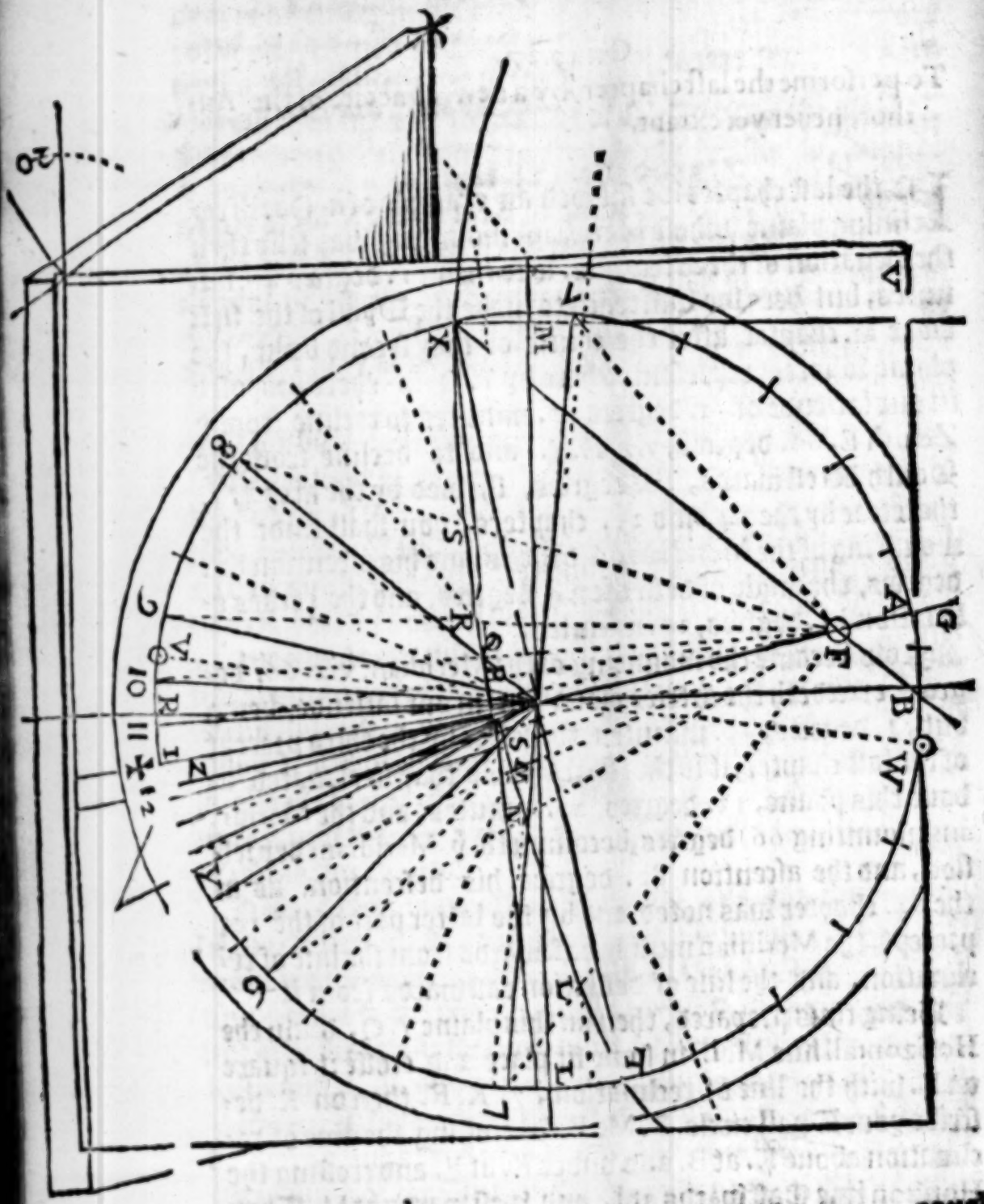
To performe the last chapter, by a new conceite of the Author, neuer yet extant.

In the last chapter we shewed an example of a North reclining plaine, whose Meridians mounting was lesse then the eleuation of the artrée, viz. lesse then 51. degrées 40. minutes, but here we will teach to make the Dyall of the first booke 21. chapter, after the course of this second booke, the plaine whereof represented here by Y. Q. is there proposed in our latitude of 51. degrées 40. minutes to recline from ỳ Zenith E. 23. degrées, viz E. Y. and to decline from the South Westwards, 20. degrées, shewed by the arch 4. 5. therefore by the 24. and 25. chapters, you shall finde the mounting of the Meridian 66 degrées, and his ascention 82. degrées, the angle of deflection 4 degrées, and the cockes eleuation 13. degrées, 20. minutes.

Now because the mounting of the Meridian, viz. 66. degrées, exceedeth the artrées eleuation in our latitude, being but 51. degrées, 40. minutes, therefore by the third precept of the last chapter, it is the South pole that is eleuated aboue this plaine, 13. degrées, 20. minutes, and the Meridians mounting 66. degrées, becommeth ỳ Meridians depression, and the ascention 82. degrées, his descention, as in the 24. chapter was noted, and by the latter part of the 10. precept, the Meridian must ly eastwards from the line of reclination, and the line of deflection eastwards from it.

Being thus prepared, then on this plaine Y. Q. draw the Horizontall line M. L. in some fit place and crosse it square on K. with the line of reclination, 7. K. R. then on K. describe your Dyall circle, B. M. R. L. crossing the line of reclination aboue K. at B. and vnder K. at R. and crossing the Horizon line Eastwards at L. and westwards at M. Then accor-

according to the said 3. and 10. precepts, set L. I. in L. R.



equal

equall to the Meridans descention 82. degrées, and set I. Z. in I. L. equal to the angle of deflection, 4. degrées & thereby draw the Horizontall Meridian, K. I. and the line of deflection K. Z. and extend Z. K. beyond K. crossing the Dyall circle at A. then crosse A. K. Z. square with another dyametre. X. K. T. Then set T. D. in T. Z. and A. B. in A. T. each equall to the cockes eleuation, 13. degrées. 20. minutes, & extend the lines, X. B. to crosse A. K. at F. and X. D. to crosse K. Z. at 3. then extend the line X. G. to crosse the line K. A. extended at G. so that it make with X. F. an angle G. X. F. equall to F. X. K. then on G. with G. X. or G. T. describe an excentricke arch, X. 3. T. which shall iustly cut the point 3. if you haue done well.

These things done, then draw the line F. I. crossing this arch, X. 3. T. at O. then extend K. O. to crosse the Dyall circle at V. then draw the dyametre, V. K. W. and make at each end a rundle to know him by, which you shal call the prime dyametre, because it limitteth the beginning of the deuisions: for from it you shall now diuide the two semy-circles, V. X. W. and V. T. W. each into 12. equall parts, by which, and a rule laide from the centre K. you shall diuide the excentricke circle, X. 3. T. into so many vnequall parts, or into so many as shall bee needfull, which I haue marked on each side of O. with P. Q. R. S. &c. Then by a rule laid from F. on euery of those vnequall parts, of that excentricke circle X. 3. T. or so many as shall be needful, you shall diuide the two semy-circles V. X. W. and V. T. W. each into 12. vnequall parts, and those shall be the width of your howerlines for this dyall: and therfore I haue marked them with the numbers fitting them, viz. with 1. 2. 3. 4. 5. 6. 7. &c. Eastwards, from the Meridian or twelue of clocke line K. R. and with 11. 10. 9. 8. 7. 6. &c. Westwards. Lastly I draw the howerlines, K. 1. K. 2. K. 3. K. 4. &c. as this figure sheweth, and your dyall is made.

Lastly, set Z. Y. 13. degrées 20. minutes, in Z. T. and draw the line K. Y. which is the eleuation of this dyals

cocke, aboue the line of deflection, K.Z. wherein hée muſt ſtand.

CHAP. 28.

How geometrically to deſcribe an arch propoſed without reſpect of the centre.

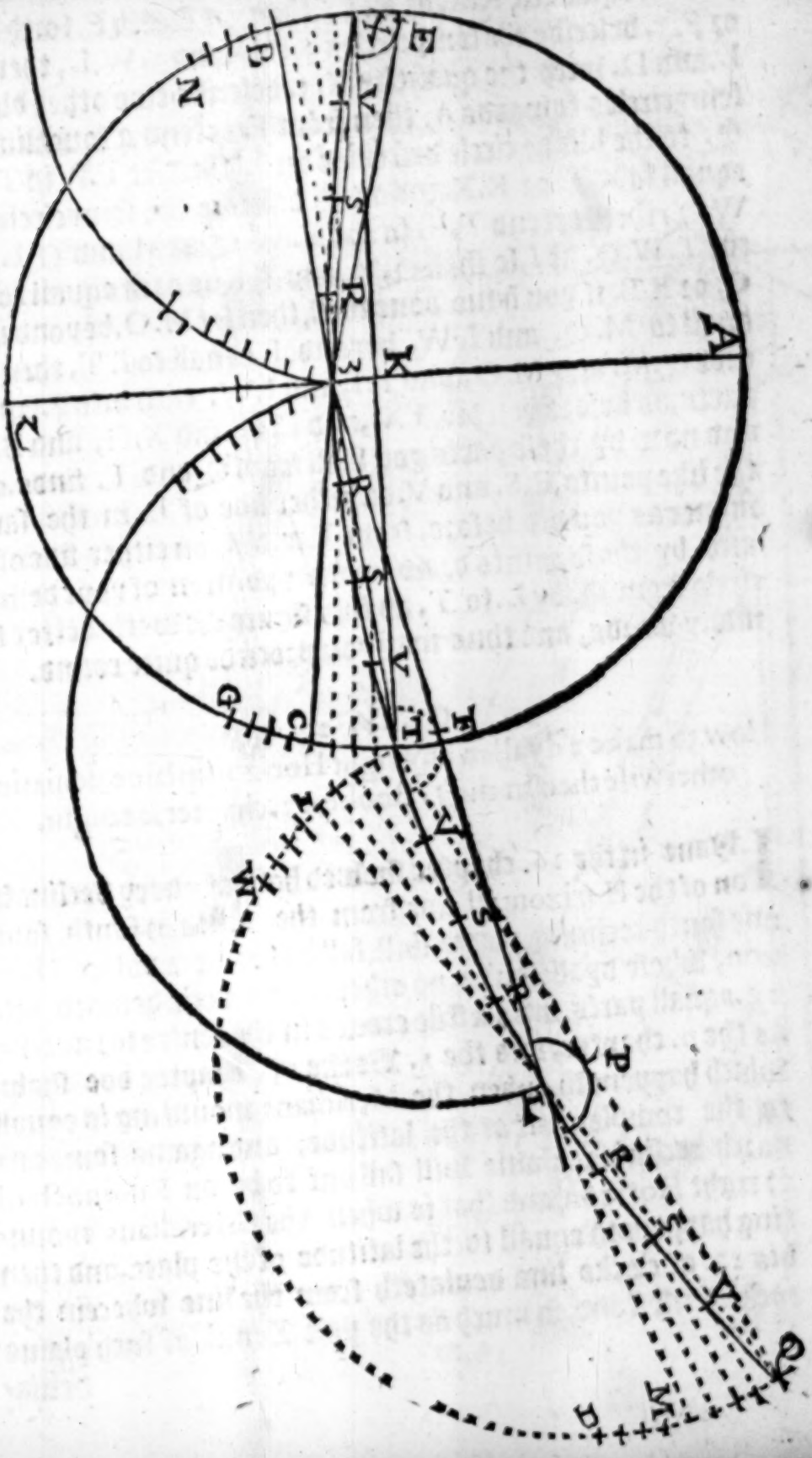
BEcauſe the center of the arch X.3.T. of the laſt chapter falleth out ſo remote, that it hardly will come within ỹ compaſſe of any reaſonable plaine, I could not but hære ſhew how to deſcribe it, though the centre bee not had.

Extend therefore X.3. to cut T.Z. at C, and T.3. to cut X.Z. at B, then deuide T.C. & X.B. each into like number of equall parts the more better, but here haue I deuided each with 3. points into 4. equall parts, which is ſufficient, then ſet C.G. in C.Z. equall to C.T. and B.N. in B.Z. equall to B.X, and deuide thoſe alſo into the like number of the ſame parts, then laying a rule on X. and the parts of T.C, draw 3. blinde lines from T.C. till they croſſe T.3, which done, lay your rule on T, and the point of B.N. nert B, and thereby croſſe the blinde line nert C, at which croſſing, ſet ỹ point R, then your rule laid againe from T. on the ſecond point from B. of B.N, croſſe thereby the ſecond blinde line from C. at which croſſing ſet S: againe from T. by the 3. point of B.N. croſſe the third blinde line, there ſet V, which done, you may with your hand by thoſe points, 3.R.S.V. and T. draw the arch 3.T.

Then you ſhall from T. by the 3. points of X.B, draw the like blinde lines onely to touch 3.X. which done by a rule laid from X. on the 3. points of C.G, you ſhall croſſe each blinde line as you did before, and ſet the points R.S.V. on that ſide, as before you did in the other, and by them draw the arch X.3, ſo haue you the whole eccentricke arch X.3.T. deſired.

If you yet deſire more of the ſame circle, take the width 3.K and therewith on X. and T. deſcribe two blinde ſemy-circles towards A, then from 3. draw touchlines to them, viz. 3.E.D. and 3.F.L, then ſet 3.E. in 3.D, and 3.F. in 3.

L.

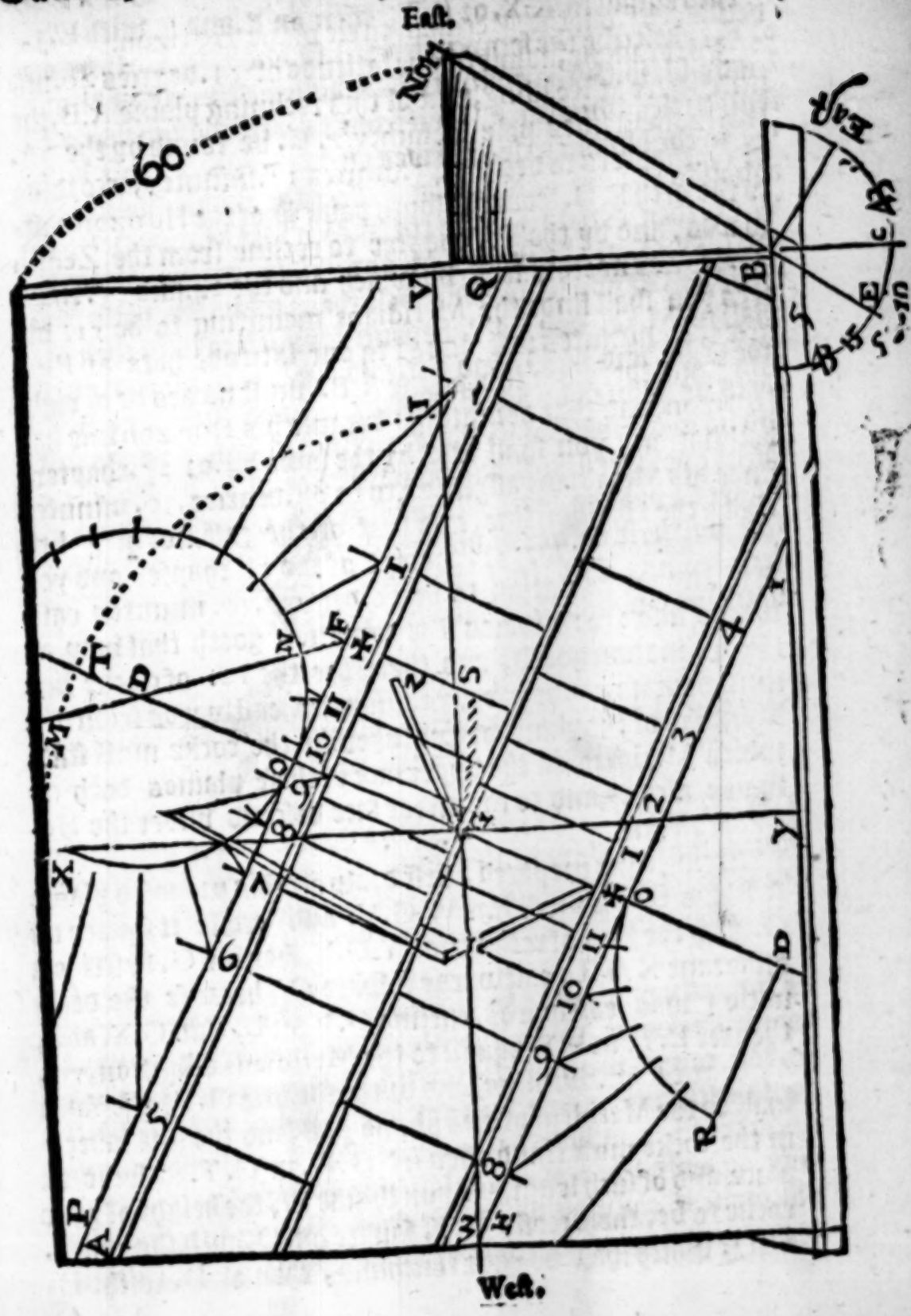

P
N
E
V
S
R
A
K
Z
G
C
F
M
P
Q
D

L. each equall to K.X. or K.T, then on E. and F. with E.3. or F.3. describe the semycircles 3.P.D. and 3.W.L, then on L. and D. with the quantity K.3. describe two other blinde semycircles towards A, then from T. extend a touchline T. Q. to the blinde circle described on L, then set T.P. in T.Q. equall to K.T. or K.X, and on P. describe the semycircle T. W.Q, then extend T.L. to cut T. W.Q. at M, and Q.L. to cut T.W.Q. at I, so shall Q.M. and T.I. be each equall to T. C. or X.B. if you haue done well, then set M.O. beyond in equall to M. Q. and I. W. beyond I. equall to I. T, then deuide Q.M. and M.O, and T.I, and I.W. each into 4. equall parts, as before you did, T.C, and C.G, and X.G, and B.N. and now by these parts you shall from Q. and T. finde out the like points, R.S. and V. on either side of L. in the same maner as you did before, from T. and X. on either side of 3. and by those points draw another position of your desired circle from Q. by L. to T, as this figure sheweth better thē many words, and thus may you proceede quite round.

CHAP. 29.

How to make a dyall to any right Horizon, plaine deuiating otherwise then in the 1. Booke, 22. chapter is taught.

I Haue in the 26. chapter shewed how at euery declination of the Horizontall line from the north or south, some one south reclining plaine will fall out to be a polare Horizon, whose dyall can be no other then a circle deuided into 24. equall parts, with a stile erected in the centre for a cocke, as the 9. chapter, and the 1. Booke 15. chapter doe shew, which happeneth when the Meridians mounting is equall to the complement of the latitude, and againe some one north reclining plaine will fall out to be an Equinoctiall or right Horizon, and that is when the Meridians mounting happeneth equall to the latitude of the place, and then his 12. of clocke line deuiateth from the line wherein the cocke must stand, so much as the pole Zenith of such plaine deuia-


East.
North.
60
EAST
SOUTH
West.

deuiateth from the Meridian circle of the Horizon.

For example, admit in our latitude of 51.degrees 40.minutes here at Reading, that of this reclining plaine A.B. the Horizontall lines pole Zenith, viz. C. be found by the 14. or 15.chapters to decline 43.degrees 15.minutes, according to the arch E.C. from the south point E. of the Horizon eastwards, and by the 21. chapter to recline from the Zenith 30.degrees northwards, by which and the 24.and 25.chapters you shall finde the Meridians mounting to be 51. degrees, 40. minutes iust equall to our latitude here at Reading, and therefore this plaine A.B. must nedes be a right Horizon, and that deuiating, because his Horizon line had declination, you shall also by the same 24.or 25.chapters finde his Meridians assention to be 64.degrees, 30. minutes aboue the Horizon line, and that on the east side of ẏ line of reclination by the 11. precept of the 26.chapter, and you shall find the deuiation to be 26.degrees, 30. minutes eastwards also: for allwaies the deuiation goeth that way as the declination goeth, and therefore the 12. of clocke line must deuiate 26.degrees, 30. minutes eastwards from the Meridian of the plaine or line wherein the cocke must stād, which Meridian to the vpper face of these plaines doth allwaies ascend, and to the vnder face descend vnder the Horizontall line.

Being thus prepared, first draw on this proposed plaine A.B the Horizontall line W.G.V. and crosse it square on G. with the line of reclination Y.G.X, then on G. describe a quadrant X.T.L. eastwards towards V. because the declination was eastwards, cutting G.V. at L, and G.X. at X, then set L.T. in L.X. equall to the Meridians assention, viz. 64. degrees, 30. minutes, and draw the line G.T, the same shall be the Meridian of this plaine A.B, and the line wherein the cocke must stand, then set D.O. in G.T. in some fit place, and of such length as you thinke fit, the height of your cocke to be, then crosse G.T. square on O. with the line P. O.Q. which shall be your touchline, then on D. with. D.

O.

O. describe your Equinoctiall circle M. O. N. then set O.N. in O.N.M. equall to your deuiation viz. 26. degrees, 30. minutes, viz. eastwards from ☉, because the declination was Eastwards, then extend M. D.N. to crosse the touch line P. Q. at F. and draw F. S. parrallell to G. T. I say that F.S. shall be the 12. of clocke line, which by reason of the declination aforesaid, is deuiated from G. T. the Meridian of the plaine, his true place if no declination had bene according to the distance O. F.

Lastly diuide each moyty of that Equinoctiall circle M. O. N. into 12. equall parts, making in the whole, 24. parts viz. 12. on each side of M. N. and from D. extend blind lines through as many of those 24. parts as will fit to crosse the touch line P. Q, by euery of which crossings you shall draw the howerlines all parrallell to G. T. as the vpper part of this figure sheweth, and make a streight limbe to receiue the numbers of the howers, as here you see. The cocke to this dyall, may be the stile G. Z. equall to O. D. erected plum vpright in G. as the first booke 9. chapter teacheth, but yet a long square, equall in height to D. O. or G. Z. is better, especially if you put in the howers of other countries, as the 33. and 34. chapters doe teach.

Chap. 30.

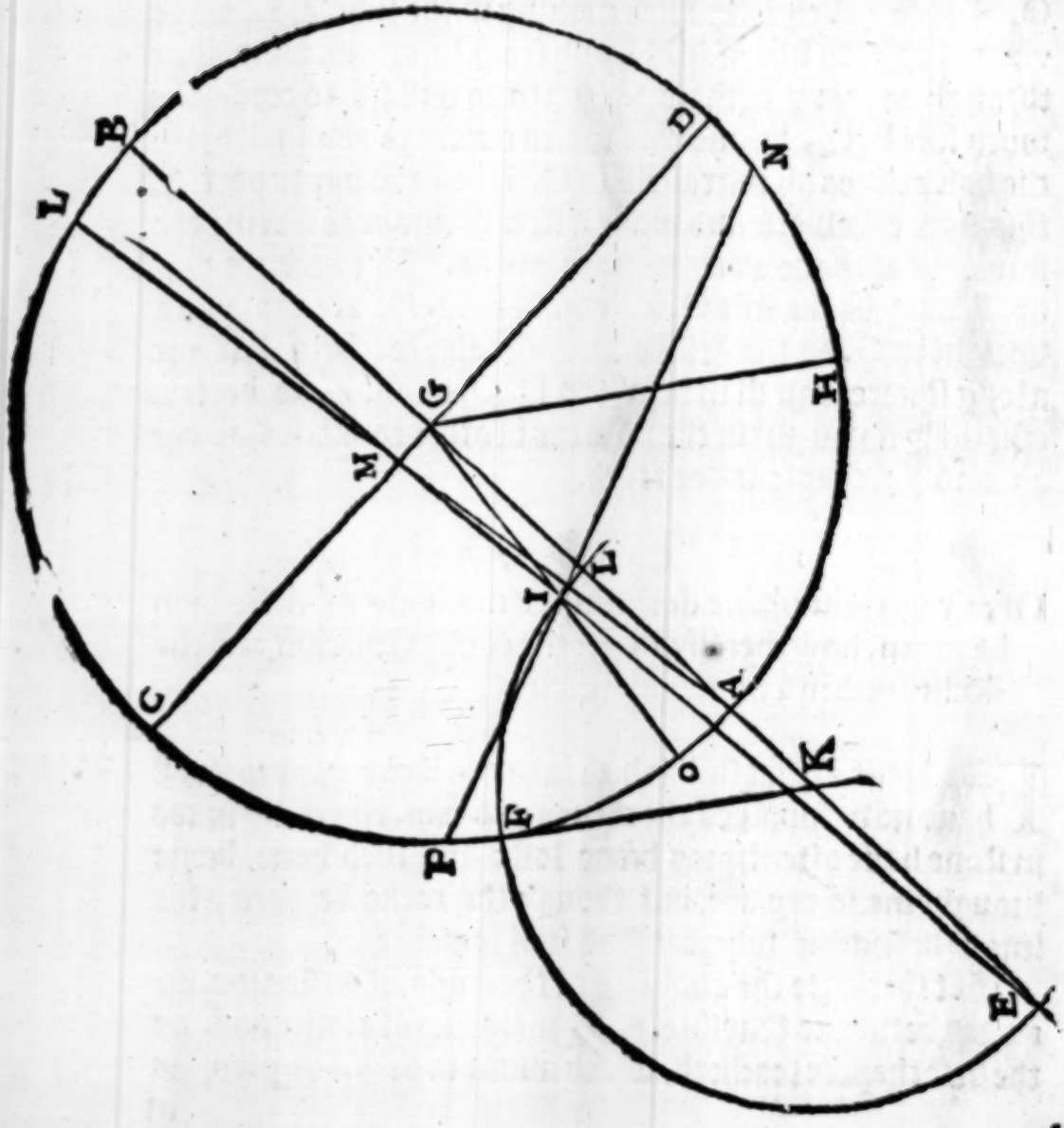
Of any vpright plaine declining, if the angle of deflection be giuen, how thereby to get the cocks eleuation, and the declination in a knowne latitude.

For want of that skill which in my 1. booke 25. chapter, I haue now supplyed the cockes of dyals, especially made in stone haue oftentimes bene lost: and such haue bene brought me to repaire, but though the cocke be gone, the line of deflection where it stood will remaine.

Get therefore the quantity of the angle of deflection included betweene that line, and the twelue of clocke line, as the first chapter teacheth, which admit to be 9. degrees, as

in

in the dyall of the 19. chapter, which had describe on G. the the circle. A.C.B.D. and quarter it square with two dyametres, A.G.B. and C.G.D. then set A.O. in A.C. and D.N. in D.A. each equall to the deflection, viz. 9. degrees, and drawe G.O, then set C.F. in C.A. & A.H. in A.D, each equall to the latitude, which in the said 19. chapter was 51. degrees 40. minutes, and drawe G.H. then drawe F.K. parrallell to G.H. cutting G.A. extended at K. then on K. with K.F. describe the semycircle E.F.L. cutting G.K. extended



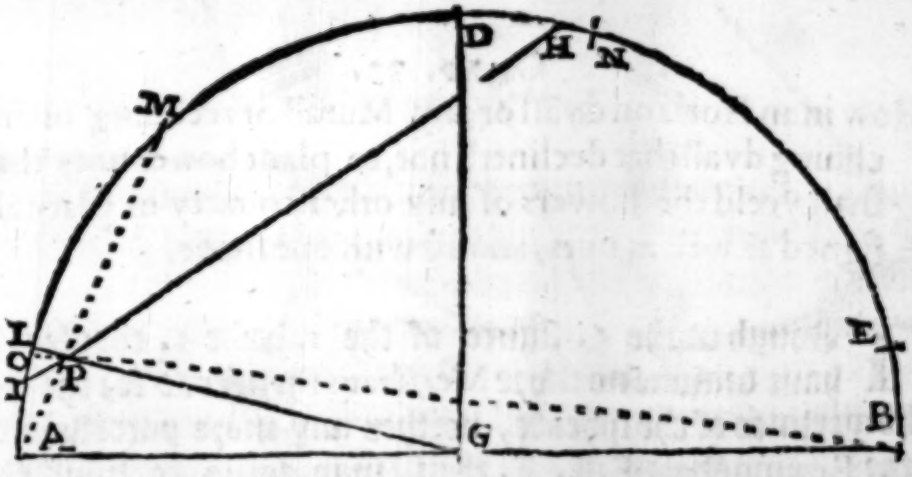
at

at E. and G. O. at I. then extend E. I. to cut G. C. at M. then extend A. M. to cut B. C. at L. Lastly extend N. I. to cut O. C. at P. I say now that O. P. is the eleuation of the cocke of that dyall, which by the 1. chapter you shall finde to be 37. degrees, 30. minutes, and that B. L. is the declination of the plaine whereon that dyall is made, which by the first chapter you shall find to be 11. degrees: therefore by the first you may fashion a new cocke to the Dyall, and by the second set him in his due place, according to his declination.

Chap. 31.

How to drawe the prime dyametre mentioned in the 27. chapter, where direction wanteth.

I shewed in the 28. chapter how to draw the excentricke arch, X. 3. T. of the 27. chapter, because the Centre was vnreasonable remote: and since I finde by reason of the short direction of K. O. in the same chapter, that the prime dyametre V. O. K. W. is not easily to be drawen truly, and thereby all the dyall disordered.



You shall therefore describe a very large Semy-circle of a foote dyametre at least, as A. D. B. and halfe it with G. D. then set A. L, in A. D. and D. H. in D. B. each equall to the

cockes elevation viz. 13. degrées 20. minutes, and set L.I in L.A. equall to the degrees of deflection, viz. 4. degrées, then draw G.L. & also H.I. cutting G.L. at P. then extend A.P. to cut A.D. at M. and B.P. to cut A D. at O. then set B.E. in B.D. equall to A.O. Lastly diuide E M. in halfe at N. I say N.D. which by the first chapter you shall find to be 17. degrées is, or should be the iust quantity of Z.V. in the 27. chapter, if the direction from K.O. had there been sufficient.

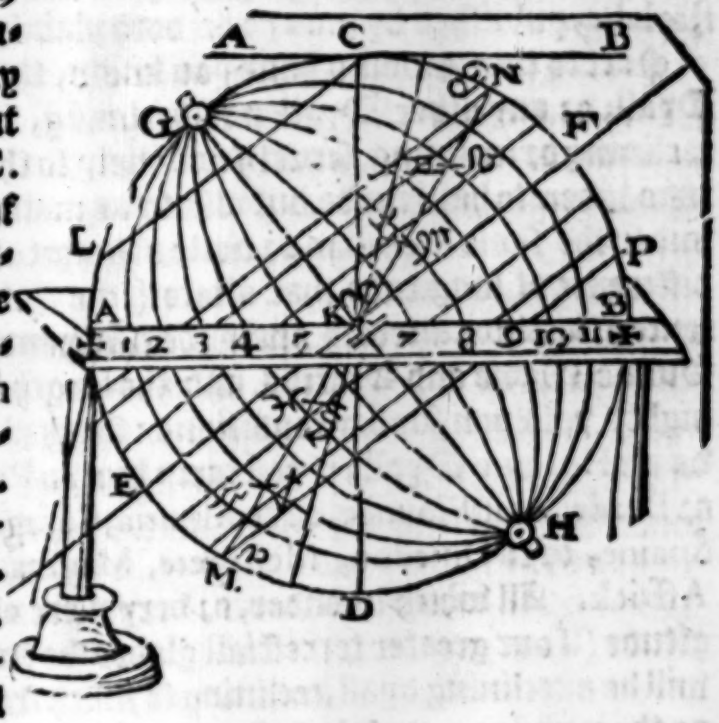
I could here set downe a number of chapters more with a mutter of blinde Dyagrams, seruing to pretty purposes about this art of dyalling, but being loth now to be tedious, neither affecting the name of a Dyagrammaticien, I do reserue them to the next impression of my Mathematicall Iewell, which shortly must be where the Theoricke of them as well as the practise, will most liuely appeare, and be most excellent introductions for the liuely vnderstanding of a number of spherical matters, fit as wel for Cosmographers, Nauigators, and such like, as for dyalling: I wil therefore diuert and try another straine, and adde something extraordinary to this art, differing from the conceites of other Authors.

CHAP. 32.

How in an Horizon dyall or any Murall or reclining or inclining dyall that declineth not, to plant hower lines that shall yeeld the howers of any other country or place assigned as well as ours, and all with one shade.

THough in the 3. figure of the 1. booke 1. chapter. I haue drawne no more Meridians then serue for the 24. howerlines of the spheare, neither any more parrallels to the Equinoctiall E.K. F. then may serue to limit the Sunnes declinations, which are sufficient for this Art of Dyalling. Yet Cosmographers will haue so many Meridians, as there be degrées, or rather minutes in the Equinoctiall

ctiall, E. K. F. which they call circles of longitude, and so many parrallels as there be degrees, or rather minutes in ỹ Semy-circle G. E. H. or G F. H. of the same three figures growing lesse and lesse from the Equinoctiall either way, euen to a point at either pole G. and H. which they call parrallels or circles of latitude, whereupon euery Horizon of the world is denominated by that parrallell of the spheare, which cutteth or toucheth the very Zenith point therof, as L. C. in the third of those three figures heere present touching ỹ Zenith at C. the latitude of L. C. from ỹ Equinoctiall E. F. being F. C. which is alwaies equall to the poles eleuation, A. G.



The parrallels of latitude they number from the Equinoctiall E. K. F. either way, ending at either pole, G. & H. wch 90. but they begin the numbring of their circles of longitude, in these dayes at the Ile of S. Michaell, among the Iles called the Azores almost 30. degrees west from England, because of late they haue there found the sea compasse to haue no variation, which with vs varieth about 11. or 12. degrees; but in old time, they numbred these circles of longitude from ỹ Iles called Insula infortunate, thinking there had beene no land at all to be found westwards from vs be-

yond them, but now God be praised, there is another world of land found beyond them, which Ptolomeus neuer so much as dreamed of. To be short: they number those circles of longitude from that Ile of S. Michaell eastwards, and so round ending there againe, with 360. but they set those numbers to the Equinoctiall circle. All which in my Anatomy of the speare, not yet extant, are plainly set downe, and in the terrestriall Mappe which I ioyned to my Vranicall Astrolabe, published by me 1596. doth plainly appeare.

Next to this I would haue you know, that any Horizon Dyall, or any other Dyall not declining, whether Murall reclining or inclining, serueth not onely to that place or latitude whereto he is made, but also to as many places as lye vnder the same Meridian or circle of longitude (for it is the difference of longitude that altereth the howers, the difference of latitude altereth onely the rising and setting of the Sunne, Moone and Starres, and the length of the day and night) yet vpon sundry conditions: for that which is with vs an Horizon Dyall, if you carry him to Potyers, Brudge, or Burdeaux in Fraunce, or to Almiria, Caragola or Baion in Spaine, or to Omedon, Mellegete, Mayma, Benegoras in Affrick. All which ly vnder, or very nere our circle of longitude (if our greater terrestriall globes be truly described) will be a reclining dyall, reclining so much from their Zenith as the complement of the distance of their Zenith and ours are in sunder, and our North, or South wall Dyall, or a North or South reclining or inclining dyall will serue also to shew the howers in the selfe same places, but that they shall recline or incline more or lesse in euery of those places then they doe here according to ỹ distance of their Zeniths from ours.

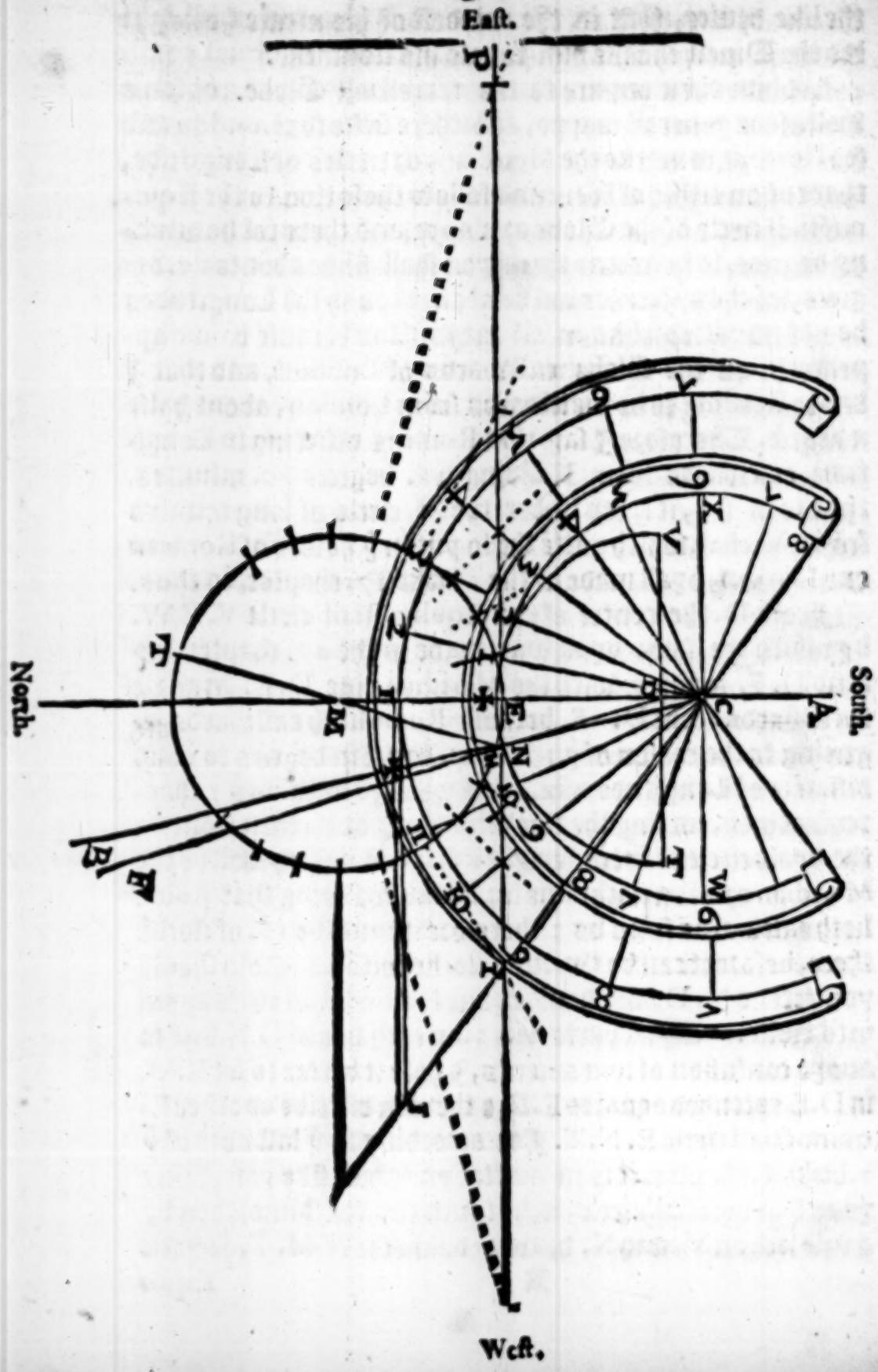
But now for example, suppose some silly Papist would be glad here about Reading to haue in his dial a deuise, to shew how the howres passe away at Rome, that vnderstanding what howre the Pope vseth to dine, he might bid much good do it him. Or that some dissembling Puritane, would haue

the

the like deuice, that in the middest of his meate he might bid the Diuell choake him to ease his stomacke.

Let him then repaire to the terrestiall Globe, or some well made generall mappe, and there seeke for London and for Rome, and marke the Meridians or circles of Longitude, that cut on either of them and follow those two, to the Equinoctiall circle of the Globe or mappe, and there tel how many degrees, is betweene them, you shall finde aboute 16. degrees, for the difference wil be al on, though the Longitudes be not numbred a like in all maps. And because Rome appeareth, on the Globe eastwards of London, and that I know Reading to be westwards from London, about halfe a degree. Therefore I say that Rome is differing in Longitude, eastwards from Reading, 16. degrees 30. minutes, that is to say, it lyeth vnder the 42. circle of long counted frō S. Michal, which gotte thē to put in ẏ bowls of Rome in our Horizon dyall made in the 1 booke 17. chapter, do thus.

From D. the centre of the Equinoctiall circle V. E W. by which the same dyall was made in the 17. chapter, extend D. F. making with the Meridian line D. E. an angle westwards from D. E, because Rome lieth eastwards, agreeing to the reason of ẏ 19. chap. equal in degrees to ẏ said differēce of Longitude, viz. 16. degrees 30. min. as ẏ 1 chapter teacheth, cutting the touchline P. Q. at N. then from C. the dyals circles centre, extende C. N. B. which shall be the Meridian or 12. a clocke line for Rome, for being that Rome lieth eastwards from vs: therefore it must be 12. of clocke there, before it can be twelue a clocke with vs. Now should you extend N. D. and deuide your Equinoctiol circle again into twise. 12. equal parts, vi. 12. on each side of D. N. but to auoyd confusion of lyneaments, I hold it better to set E. M. in D. E. extended equal to E. D, & thereon discribe another Equinoctiall circle E. N. T. For according to ẏ last note of ẏ 1. booke 2. chapter, it is no matter on which side you plante your Equinoctiall circle, so he touch the touchline, then by a rule laid on M. and N. draw a diametre N. M. T. to your


East.
North.
South.
West.

Equinoctiall circle, S. N. T. then deuide the two halues of this Equinoctiall S. N. T. on each side of S. M. T. each into 12. equall parts, making in the whole 24. parts. Then by a rule laid from M. on so many of those 24. parts, as you you shall nœde of each after other, you shall crosse the touch-line P. Q. in new places, differing from those of the 1. booke 17. chapter, by euery of which crossings you shall from the dyals centre, C. draw the howrelines of Rome desired.

But to auoyde confusion of both howrelines, you shall some inch or two without your dyall circle X. E. W. describe, a dyall circle for Rome, wherein to set the numbers for the howres of Rome one each side of the 12 of clocke line, N. M, as best fitteth, and let the howrelines of Rome, rest betweene the two circles and not come among the first howerlines, also you must extend the cocke of your dyall, as far out from the centre C. as the dyal circle of Rome requireth, all which this figure may shew you better then infinite words.

So that vpon the matter, now the dyall is made, it is but in nature of such a declining dyall as the 19. chapter teacheth: and therefore the reason easily perceiued, it may also as well be made, as the 20. chapter teacheth. These howres do not only serue vnto Rome, but also to Salisburg in France, Prag Brandeburg in Germany, Sterni, Netra, Tuna, hauing on the east side of Noruegia, & to Katwick in Finmark, and many more which are all vnder the same 42. circle of longitude with Rome.

Chap. 33.

To know how much the Meridian of any Murell or reclining or inclining plaine, declining differeth in Longitude from the Meridian of your Horizon, and to what countries that Meridian serueth, & to set in howres appertaining.

If your declining dyall be made in maner of the 19. chapter, then get the degrees of the angle O. D. H. or G. D. L. equall

equall to it in that Dyall, which by the first chapter you shall finde there to be 14. degrees, 30. minutes, if in manner of the 20. chapter then shall the arch E. V. of the Dyall circle there be the selfe same, viz. 14. degrees, 30. minutes, which I say is the difference of longitude desired, and that Eastwards from our Meridian, because the wall there proposed declineth Eastwards.

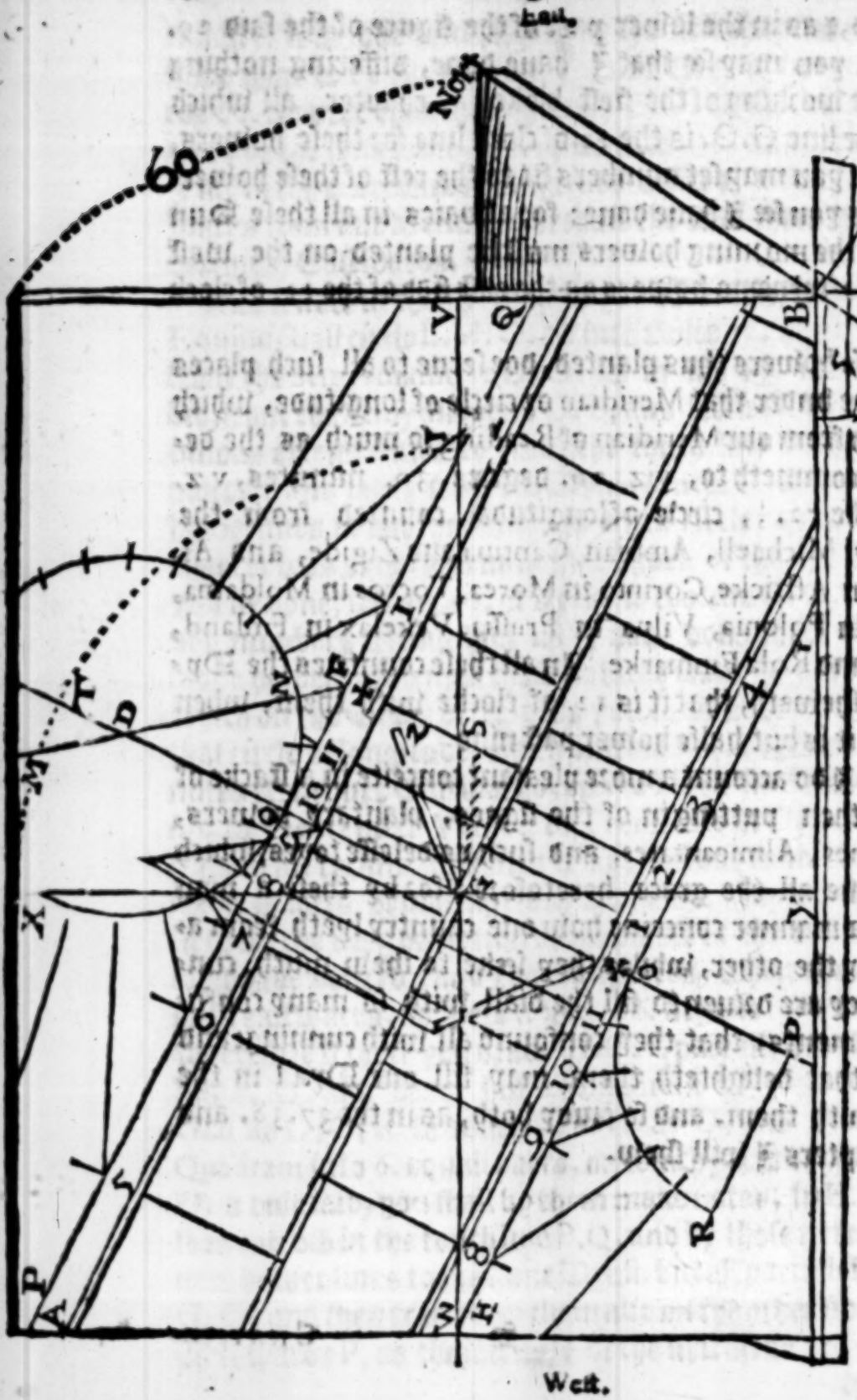
And if now in the 19. chapter you doe but new diuide the Equinoctiall circle L. M. O. N. into twice 12. equall parts, from the Semy-diametre D. O, as in the 19. chapter you did, from the Semy diametre D. B, and from D. by those diuisions extend lines to crosse the touch line P. Q. in newe places: and lastly from the Dyals centre G. extend newe howerlines to another limbe or Dyall circle, as in the last chapter was done, and as in that figure of the 19. Chapter you see done, setting 12. of clocke to the line G. O, & the rest of ỹ numbers fitting him as I haue done there the forenoone howers: So shall those howers serue to euery place which on the Globe or Mappe you shall finde to lye vnder that circle of longitude, which differeth 14. degrees, 30. minutes from ours Eastwards, viz. to Digir in Affrik, to Tunis, to Trente nere Venice, to Troosslicke in Germany.

Now for reclining plaines which fall out to be right Horizon plaines deuiating, such as the 29. chapter sheweth, in them the very deuiation of the plaine is the difference of longitude desired: and that eastwards, when the deuiation is eastwards, as there it was 26. degrees 30. minutes: wherefore if there you draw H. O. I. parrallell to the touch line P. Q. and draw but a Quadrant of your Equinoctial, as D. O, R. to touch H. O. I. at O, and diuide that Quadrant into 6. equall parts, on which parts of his Centre D. a rule laid, you shall by them make notes, in H. I. as before you did in the touch line P. Q. and by those notes draw new howerlines to the same Dyall, but all parrallell still to G. O. and then transferre them also on the other side, of G. O. towards P, as the last note of the first booke 16. chapter teacheth,

teacheth, as in the lower part of the figure of the said 29. chapter, you may see that I haue done, differing nothing from the working of the first booke 16. chapter, all which done, the line G.O. is the 12. of clock line for these howers, and by it you may set numbers fit to the rest of these howers lines, as you see I haue done: for alwaies in all these Sun Dyals, the morning howers must be planted on the west side, the afternoone howers on the east side of the 12. of clock line.

These howers thus planted, doe serue to all such places which lye vnder that Meridian or circle of longitude, which differeth from our Meridian of Reading so much as the deuiation commeth to, viz. 26. degrees 30. minutes, vz. vnder the 52. ½, circle of longitude, counted from the Ile of S. Michaell, Ambian, Cantiua and Zigide, and Albaijadi in Affricke, Corinto in Morea, Tocros in Moldania, Lutsko in Polonia, Vilna in Prussia, Vekelax in Finland, Omba and Rola Finmarke. In all these countries the Dyall now sheweth, that it is 12. of clocke with them, when with vs it is but halfe howr past nine.

This I do account a more pleasant conceite in a stacke of Dyals, then putting in of the signes, plantary howers, Azimuthes, Almicantares, and such needelesse toyes, which hath beene all the grace heretofore: for by these a man may in a manner conceiue how one country lyeth from another by the other, whiles they seeke to shew much cunning, they are driuen to fill the dial with so many confused lineaments, that they confound all with cunning: and yet hee that delighteth them, may fill one Dyal in the stacke with them, and so enioy both, as in the 37. 38. and 39 Chapters I will shew.


East.
North.
60
West.

Chap. 34.

TO know vnto what place of the world any Mural or reclining or inclining Dyall declining, shall become an Horizon Dyall, or a South wall Dyall, hauing his owne proper howrs, as the last chapter teacheth.

SUch Dyals as with vs doe not decline, serue as before is said, to all places lying vnder our longitude to shew the howre of the day; but no one Dyall can be a Horizon Dyall to euery such place: Ye can serue as an Horizon Dyall onely to that one of all these places, whose latitude is iust equall to the cockes eleuation, viz. hauing the same pole so much eleuated, when as therefore a plaine or Dyall is proposed declining, you may be sure the longitude of that plaine differeth from ours as well as the latitude, according as he declineth more or lesse, and hauing gotten the longitude by the last chapter, the latitude of the place desired, must be equall to the cockes eleuation: therefore seeke on the Globe, that point where that longitude and new latitude doe crosse, and there is the place desired.

For example. Admit of the plaine Y. Q. of the 27. chapter, we desire to know to what place the Dyal thereon made shall be an Horizon Dyall, if his owne proper howerlines be thereon described, as the last chapter teacheth, that is to know to what country that Horizon doth serue, in whose plaine that plaine Y. Q. doth lye, the cockes eleuation by ỳ 27. chapter is 13. degrees 20. minutes towards the South pole, and the angle V. K. Z. you shall find by the first chapter to be 17. degrees, which by the last chapter is the difference of longitude of K. Z. the Meridian of the plaine Y. Q. from our Meridian here at Reading, and that westwards, because the declination is there proposed to decline 20. degrees westwards, take therefore 17. degrees out of our longitude here at Reading, (being as it is said 25. degrees 30. minutes) so resteth but 8. degrees 30. minutes,

and so much is the longitude of that plaine Y. Q. counted from the Ile of S. Michaell, take therefore the point of the Globe where the 8. circle of longitude and the 13.½. parrallell of South latitude doe crosse, which you shall finde nere the Wester coast of Affricke in the sea, and there shall bee the place, if there were any land, where that plaine Y. Q. should be Horizon, and his Dyall made with his proper howerlines an Horizon Dyall.

And if you would know to what place that plaine, Y. Q. should be a seuth wall, you may be sure, still it must be vnder the same 8. circle of longitude, but the eleuation of the cocke must be of the contrary pole, viz. of the north pole, so much as the eleuation of the cocke of this dyall lacketh of 90. degrees, as is taught in the beginning of the 18. chapter of ỹ 1. booke which is 76 degrees 40. minutes Therefore seeke on the globe or mappe, where the 76.½ parallel of north latitude, crosseth the said 8. circle of longitude, which you shall finde very farre towards the North pole, almost in the middle of Greenland, I say in that country, that plaine Y. Q. were a full south wall.

CHAP. 35.

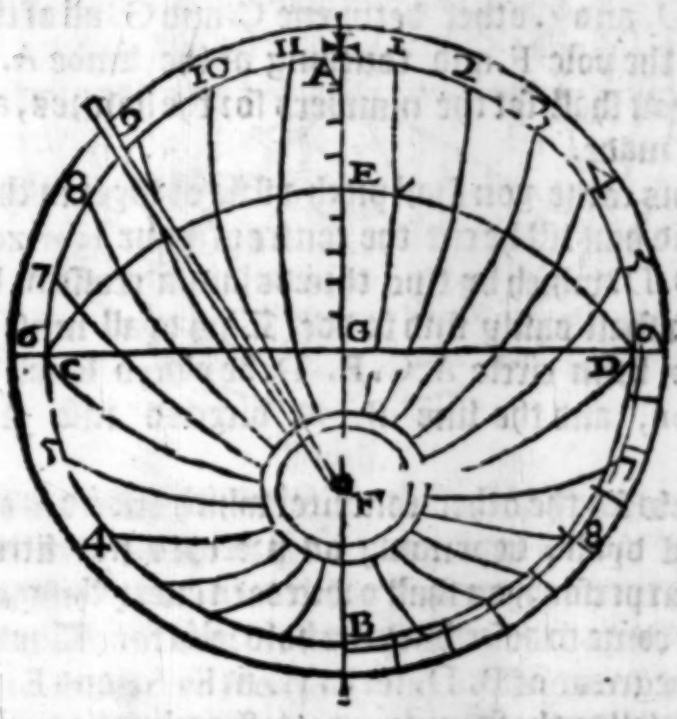
How to make a dyall in a concaue Hemisphere of a globe two seuerall waies.

THere are two conceits for making a dyall in a concaue globe, both which are some to be conceaued, by that I shall here shew to him, that but lightly vnderstandeth the lineaments of the globe, and to him that vnderstandeth the not, it is but lost labor to trouble him with much. The one conceit giueth the howre by the shade of the arctic, and needeth no lineaments but the Equinoctial circle, and 12 of the 24. howre circles of ỹ globe, for euery 15. Meridian is called an howre circle, the other by the shade of the globes center point, and this must haue those 12. howre circles, the Equinoctiall and the Ecliptick circles, and all the parrallell cir-

cles

cles of the sunnes declination, viz. so many as lye betweene the two Tropick circles.

Take therfore your concaue halfe globe, of which let the brime A. C. B. D. be the Horizon circle, and if for ease in making this dyal you haue a quadrant of equal side to ỹ globes Semydiametre, for which B. D. may serue deuided into 90. equall partes or degrées it is the better. This circle A. C. B. D. quartered square you shal with a lymmer rule of thinne brasse or paste bord laide on the bottome centre or Nadir point G. and the point A. and B. draw the halfe Meridian circle vnder the earth, A. G. B. let A. be north, B. South, and in like sorte draw the vnder halfe of the Vertical circle, C. G D. crossing each other square on G. let D. be east and C. west.



Then set G. E. in G. A. equall to your latitude, admit 51. degrées 40. minutes, for vs héere at Reading, by help of the degrées of B. D. taken in your compasse, that is to say, so much as the Equinoctial vnder the earth is distant from the Nadir G. of the Horizon, A. C. B. D. then set B. F. in

B. G. as much, so shall F. be the south pole, depressed vnder B. the south pointe of the Horizon, A. C. B. D. so much as the North pole with vs is eleuated, viz. 51. deg. 40. minutes, and E. and F. shall so be 90. degrées in sunder.

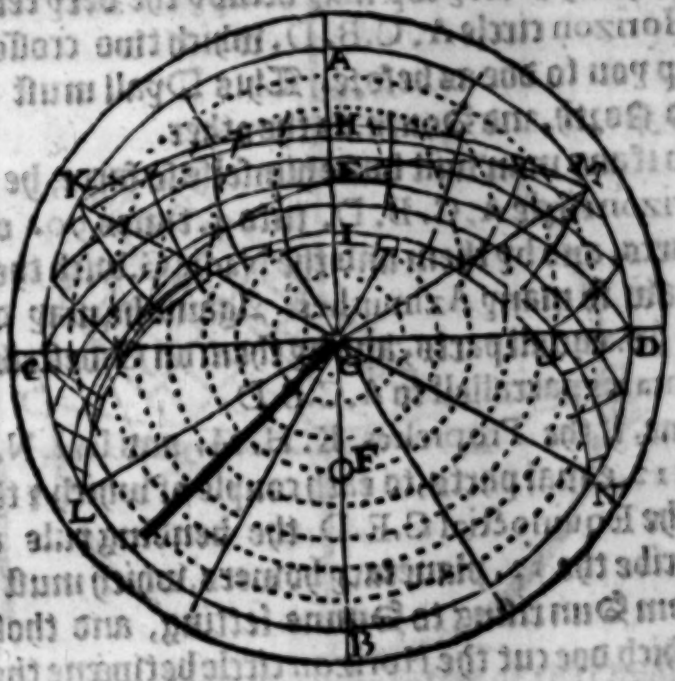
Then open your compasse to A. D. or B. D. being equall to G. D. or E. F. & therwith on F. discribe the halfe Equinoctiall circle, C. E. D. vnder the earth, which you shall put into 12. equal parts, each part being 15. degr. of B. D. Lastly with the same width A. D. or B. D. you shall pitch one foot of your compasse in that parte of the Equinoctiall C. E. D. next C. and therewith discribe the howre circle, next beyond G. then pitching in the second parte, from C. discribe the second howre circle from G. and so doe till with the same width you haue discribed 5. howre circles beyond G. towards D. and 5. other betwéene C. and G. all of them crossing at the pole F. and touching at the limbe A. C. B. D. where you shall set the numbers for the howres, and your dyall is made.

For his cocke you shall pitch a stile or wyer in the pole F. and bend him till he cut the centre of your Horizon circle, A. C. B. D. which by two threeds laid a crosse A. B. and C. D. you shall easily find to doe. This dyall must be set so, that his brim circle A. C. B. D. be placed leuell with the Horizon, and the line B. A. directed iust North and south.

Now for the other conceite, which indéed is an instrumentall dyall, depending on precepts not fitting euery common person, you shall proceede in euery thing, as before, till you come to describing the howrelines. Then by helpe of the degrées, of B. D. set E. H. in E. A. and E. I in E. G. each equall to the Sunnes greatest declination viz. 23. degrees. 30. minutes, and from F. extending your compasse first to H. then to I. draw the two Tropicke circles K. H. M. and L. I. N. and then you may either draw so much of your 12. howrelines, as lyeth betwéene those two Tropicke circles, in maner as you did before, or els with your

bending rule laid from F. on euery part of the Equinoctiall C E.D. you may draw them as well.

That done, your bending rule laid on the three points L. E. and M. draw thereby the halfe Eclipticke circle L.E.M. then put L. E. and E. M. each into 6. equal parts, so haue you 6. of the 12. signes, euery of which you may also diuide into 30. degrees, set ♈ at M. and ♎ ♑ at E. ♋ 69 at L. ♈ set back-



wards and forwards suting to these, till you haue all 12. signes, and if you did at the 20. degree of ♈ set I. for January, and at the 20. of ♓ set F. for February, and at the 20. of ♓ set M. for March and so round setting the begining of euery of the 12 monethes, to the 20. or 21. degree of the signes, which by help of an Ephimeris, or ♈ instrument of the 1. book 4. chapter, you may the more truly performe, it were in my conceite, all the better, and the rather for that ♈ degrees will sufficiently helpe to reckon the daies betweene.

Lastly diuide E.H. and E. I. each into 23. ½ degrees, and from F. extending your compasse to euery of those parts,

describe

describe the twice 23. ½ parrallell circles, of the Sunnes declination from the Equinoctiall C. E. D. either way, or else you may describe them by your bending rule, so you put the two hower lines next K. and M. into the same twice 23. ½ parts, a piece hauing so three prickes for euery parrallell.

The cocke of this Dyall must be a stile iust equall in length to the Semy-dyametre of the Globe, so plum erected from G. that his very top may occupy the very centre point of the Horizon circle A. C. B. D. which two crosse threedes will help you to doe as before. This Dyall must bee set leuell, and North, and South, as the other.

Now if any man will busie himselfe so farre, he may put the Horizon circle A. C. B. D. into 4. times 90. or 360. equall parts, and by them and the Nadir G. with the bending rule, draw so many Azimuthes. Againe he may diuide G. B. into 90. equall parts, and by them on G. describe the 90. Almicantares parrallell to A. C. B. D.

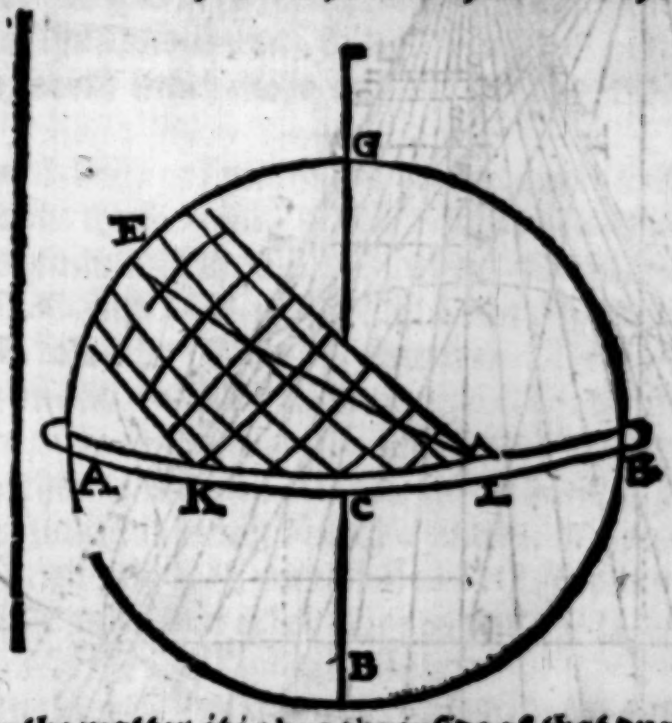
Againe, if the Tropickes K. H. M. and L. I. N. be each put into 12. equal parts, to each couple of which & the match part in the Equinoctial C. E. D. the bending rule applyed, shal describe the 12. planetary howers, which must be numbered from Sun rising to Sunne setting, and those hower lines which doe cut the Horizon circle betweene the points K. L. and M. N. doe shew the times of the sunne rising and setting, so that now it is for all day rather an instrument then a Dyall, but all those seuerall lineaments must be put in seuerall colours, so haue you but a wilderneſſe of lines, otherwise all this cunning doth but heape vp confusion.

CHAP. 36.

Chap. 36.

How to make a dyall on a conuex Hemisphere of a Globe.

In this dyall set the selfe same lyneaments on the north side aboue the Horizon circle A. C. B. D. as in the last figure are northwards vnderneath it viz. that E. be as far from the Zenith G. heere as he was therefrom the Nadir G,



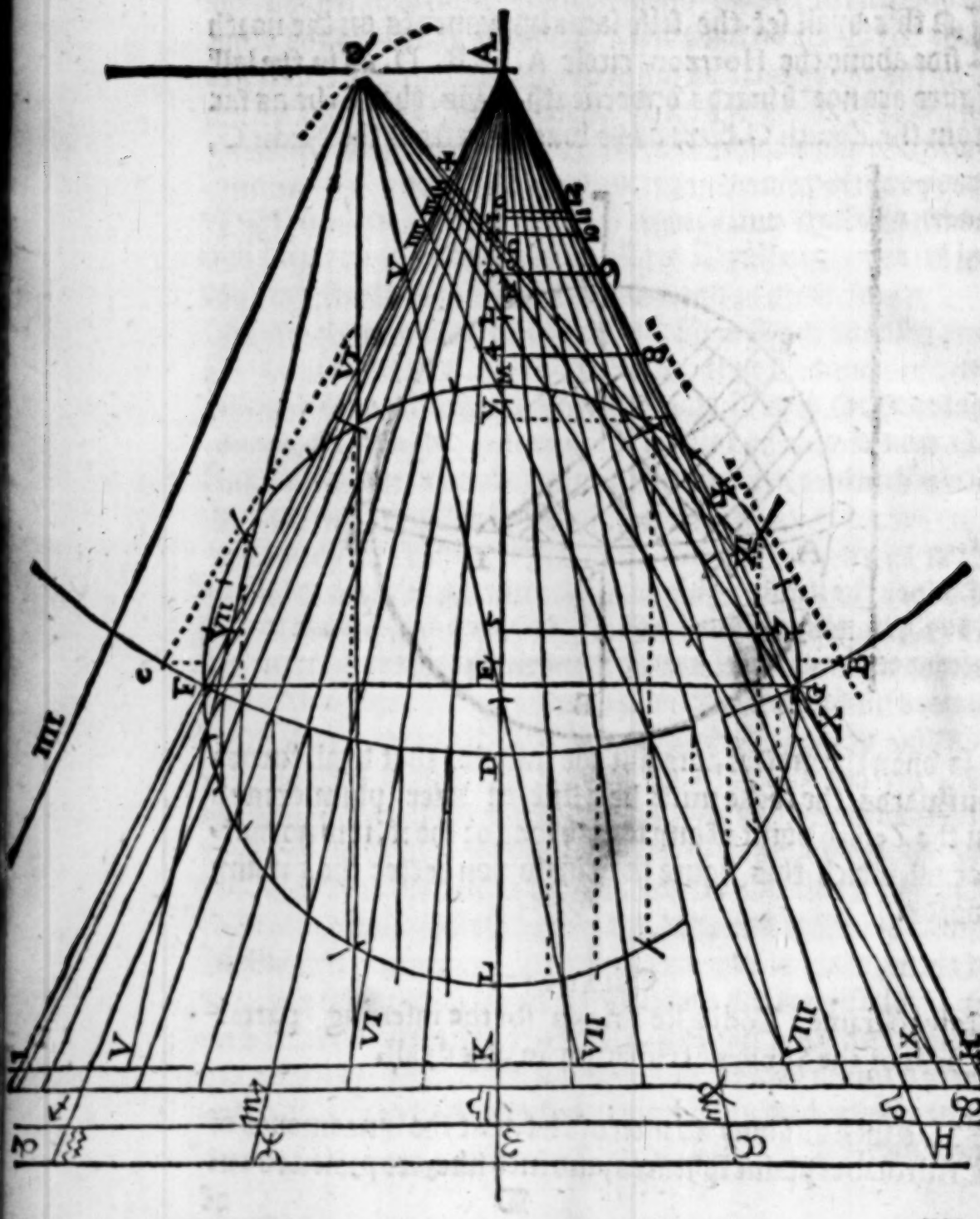
& so vpon the matter, it is but the inside of that dyall turned outwards, the cocke must be a stile or wier plum erected in the Zenith point of any length long or short, it is no matter, all which this figure may shew you better then many words.

Chap. 37.

How to frame a Zodiacke Trigon for the inserting parrallells of the Sonnes declination in any dyall.

It is well knowne to men of Art, that the lyneaments of Astrolabes plaine spheares, and such like, are projected out

of the ſpheare or globe, by radiall lines from an eye point planted on the ſuperficies of the globe, extended throw euery lineament therof, on a plaine contingente, whereon the



p20-

proiectment is made as at large in my Anathomy of the spheare, not yet extant, I haue manifested. Euen so a sun dial is but a solare proiectmēt of such lineaments of ỹ spheare as onely serue to that purpose by the suns beames, on the plaine or Horizon whereon the dyall is made, as the other is by the eye beames on his plaine contingent, the difference onely, is that for the other proiectment wee limit a fixed pointe or place to the eye, whereas for this the Sun being the eye of the proiectment, shifteth his place euery minut, which breedeth much more trouble in this then in the other.

On past-bord or some plaine bord couered with good paper, describe the Sextans, A.B.C. as the first chapter teacheth, and diuide it in the middest with A.D. then diuide the arches D.C. and D.B. each into 30 equal parts or degrées, and set F. towards C. and G. towards B. each according to the Sunnes greatest declination, viz. 23. degrées 30. minutes from D. and then draw the corde F.G. cutting A.D. at E. then extend A.F. and A.G. as farre as your sheet of paper will giue leaue, viz. to I. and H. of equall length from A. and draw I.H. parrallell to F.G. cutting A.D. extended at K. and draw other three parrallels to I.K.H. to make a limbe for our Zodiacke scale.

This done, on E. with E.F. or E.G. describe a circle F.M.G.L. cutting A.E. at M. & E.K. at L. then diuide each quarter of this circle in three parts, so haue you 12. in the whole for the 12. signes, then subdiuide each signe into 30. degrées. Then by a rule laid on the degrées of like distance from M. and L. on either side of M.E.L. or at least on euery 5. or 10. of them, draw blinde parralels to A.D. crossing the arch F.D.G. Lastly extend radiall lines from A. through euery of those crossings of the arch F.D.G. to the line I.K.H. and there set numbers to those radiall lines, and inscribe the signes limbe-like, as this picture sheweth: for at K. shall begin ♈ and ♎ at H. 69. at I. ♑.

CHAP. 38.

How to plant the parrallels limitting the signes of the Zodiacke in any Equinoctial or right Horizon dyal, by which the shade of the cocke shall shew all the yeare long, in what signe the Sunne is.

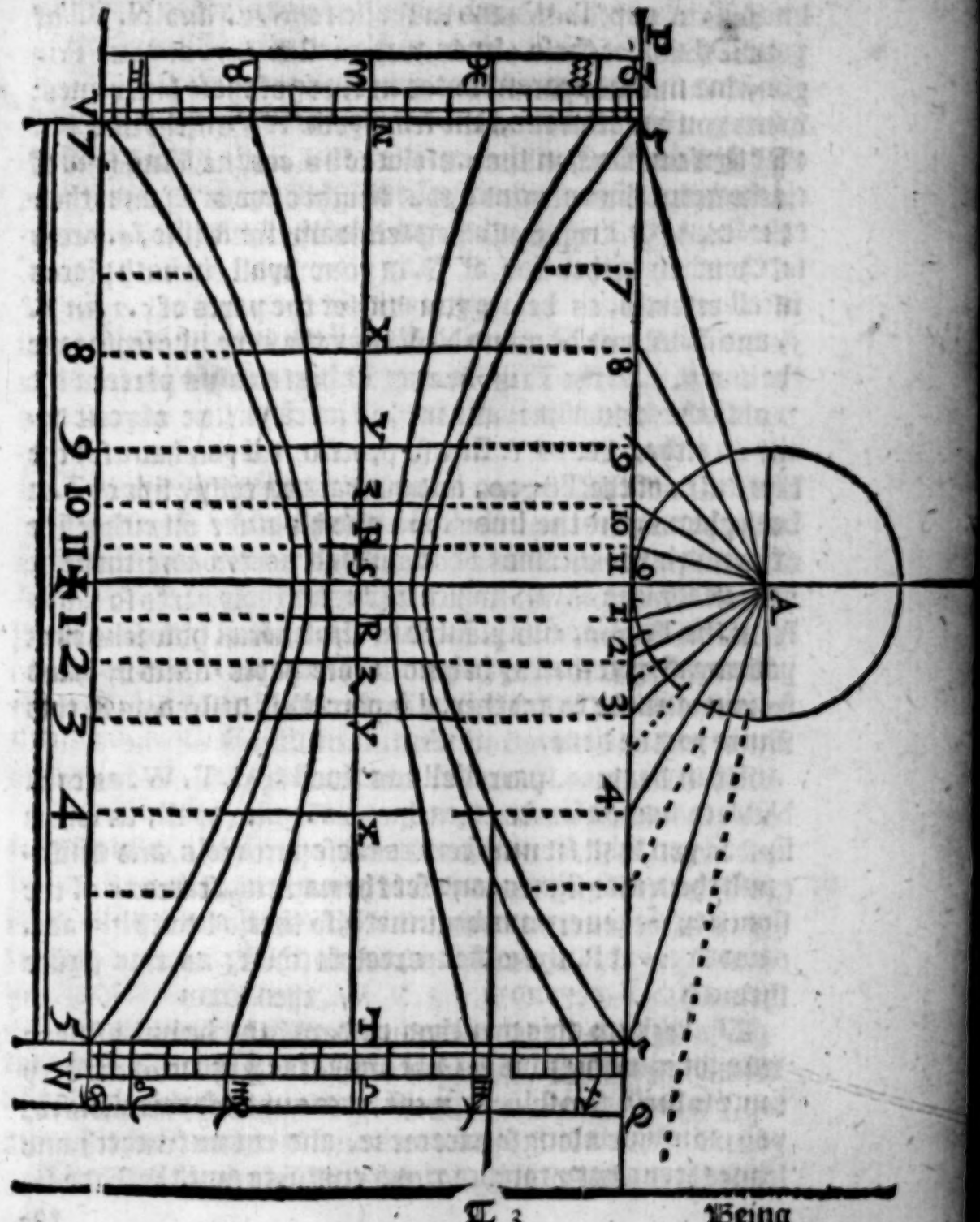
FIrst on A. describe an Equinoctial circle of such semidyametre as you intend the height of your dyals cocke to be viz. A. O. then crosse that semidametre A. O. square on O. with the touch line, P. O. Q. then diuide your Equinoctiall circle into 24. equall parts from O. through euery of which parts, or as many of them as shall be fit, which will bee but 5. on each side of O. extend lines from A. to crosse the touch line P. Q. at 1. 2. 3. 4. and 5. on the east side of O. and at 11. 10. 9. 8. and 7. on the west side in all respects, as the first booke 16. chapter teacheth, which lines may here be tearmed the Radiall lines of the Dyall: for by them the projectment of the Dyall is alwaies made as aforesaid.

This done set A. O. A. 1. A. 2. A. 3. A. 4. and A. 5. all of them taken from this Dyall in the line A. K. of the Trigon of the last chapter from A. & by euery of those points draw lines parrallell to I. K. H. cutting through all the Radiall lines of ỹ Trigon if you will, but for this dyall one halfe may suffice, as you see O. 12. 1. 11. 2. 10. 3. 9. 4. 8. and 5. 7.

Then take the line 5. 7. from the Trigon, and with that width draw N. S. T. parrallell to your touch line P. O. Q. cutting A. O. extended at S. and againe with the same width 5. 7. draw another parrallell to P. Q. as much distant from N. S. T. beyond it, viz. V. W. then draw 7. N. V. and 5. T. W. each of them parrallell to A. O. S. which indeede are the 7. a clocke hower line at Noone, and the 5. at Euen: and so shall 5. W. V. 7. be the platforme for this your Dyall, through which platforme you shall draw ỹ other hower lines from euery of the former crossings, with P. Q. crossing

the

the line N.S.T. (which is the Equinoctiall line of your Dyall, as A.K. is of your Trigon) at the points R. Z. Y. and X. on the other side of S.



Being thus prepared, take with your compasses from your Trigon all the parts of 7.5. into which it is diuided there by radiall lines, and set them one after other in the lines T.5. and T.W. and in the lines N.7. and N.V. of your Dyall: for those 4 lines are equall to 5.7. of your Trigon, and make apparant notes in euery of those foure lines: when you haue so done, take from your Trigon, the line 4.8. & set the same both in the 4. of clocke howerline, & in the 8. of clocke howreline of your dyall, on ether side of X, and then take from the Trigon, all the parts of the same line, 4.8. and set them on either side of X. in your dyall in both places in all respects, as before you did set the parts of 5.7. in T.5. and T.W. and N.7. and N.V. & in the very like sorte take the line 3.9. in the Trigon, and set him and his parte in the 3. of clocke howreline, and in the 9. of clock line of your dyall, on either side of Y. And so proceed till you haue set the line 2.10. of the Trigon, and his part on either side of Z. in both places, and the line 1.11. and his parte on either side of R. and lastly the line O.12. and his partes on either side of S, in the line A.O.S. which lines and their parts so taken from the Trigon, and planted in the seuerall howrelines of your dyall, you shall by helpe of those parts draw by hand from one pricke to another, al ỹ parrallels desired, as in this figure you see done.

Then draw 3. parrallells as well to S.T.W. as to 7. N.V. to make a limbe at each end of your dyall, in which limbes you shall set numbers to these parrallels, and distinguish them into signes, and set the names or carrects of the signes where euery one beginneth, so that ♈ be at N. ♎ at I. 69. at W. ♑ at P. the rest in order to these, as this figure sheweth.

The cocke to this dyall had need now to be but a stile or wier, of equal higth to A.O. because it is ỹ shade of the very top, ỹ when ỹ sun shineth, must trace out these parrallels, or you may haue a long square cocke, and cut out a notch, and leaue there a little tongue right ouer S. to giue the shade for

the

the same purpose.

Note that for the east and west wall dyals in euery Oblique latitude, the selfe same working serueth, but that the numbers of the ordinary howres are changed, because 6. of clocke must be there where 12. is here. And for right Horizon dyals deuiating, you must be driuen to draw the howres without deuiation, as in the 33. chapter was don, and then set in the signes to them in all respects: as before and when you haue done, then draw the deuiating howres, as the 29. chapter teacheth, and set to their numbers.

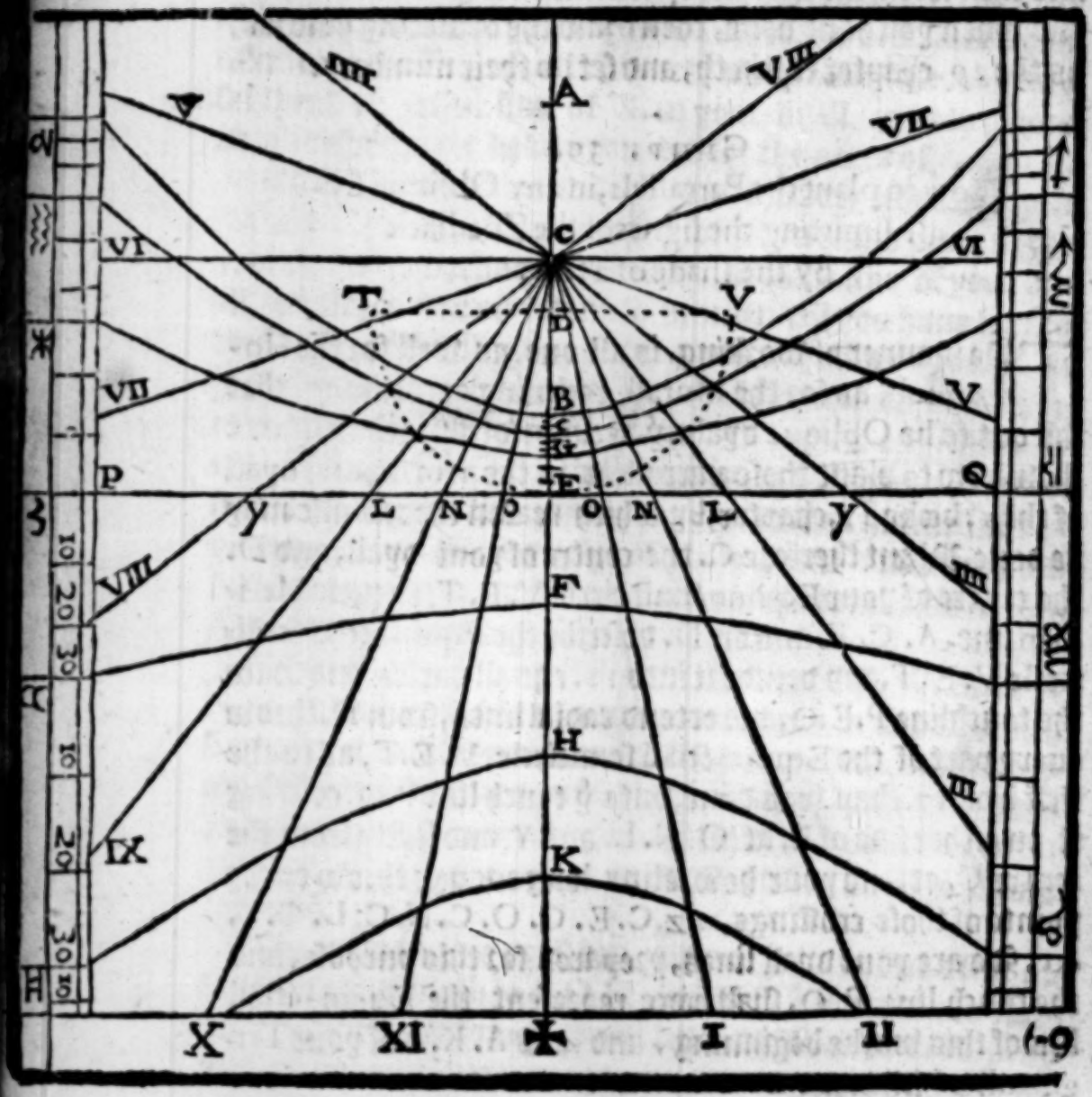
Chhp. 39.

How to plant the Parrallels, in any Oblique dyall limitting the signes of the Zoadiack by the shade of a stile.

The manner of working, is all one, as well for the Horizontall, as for the Murall, reclining or inclining, that fall out to be Oblique dyals, ỹ decline not, but we will here shew how to plant those parrallels in the Horizontal dyall of the 1. boke 17. chapter, by which reason the rest also may be done. Plant therfore C. the centre of your dyall, and D. the centre of your Equinoctiall circle V. E. T. in your Meridian line, A. C. E. and on D. describe the Equinoctial semicircle V. E. T. and deuide it into 12. equall partes, and draw the touchline P. E. Q. and extend radial lines, from D. throw euery part of the Equinoctiall semicircle, V. E. T, as in the first book 17. chap was done, vnto ỹ touch line P. Q. crossing it on either side of E. at O. N. L. and Y. and lastly from the centre C. extend your howrelins long enough throw euery pointe of those crossings, viz. C. E. C. O. C. N. C. L. C. Y. &c. So are your dyall lines, prepared for this purpose, and the touch line. P. Q. shall here represent the Equinoctiall line of this workes beginning ♈ and ♎ as A. K. is of your Trigon all which done.

Then must you prepare your Trigon to this dyall, then from

from his Centre A. extend a line A. Q. perpendicular to A. K. that way as the line of Capricorne A. I, lieth. Then take from your Dyall the Equinoctial circles Semydyametre D. E. and set A. D. in A. K. the Equinoctiall of your Trigon equall to it, then take the Semidyametre of your Dyall, viz. C. E. and therewith from D. crosse the line A. Q. of the Trigon at Q. so shall the angle A. Q. D. be equall



fa

to your cocks elevation if you haue done well, and A. Q. D. is no other then the tryangle E. H. C. of the first booke 17. chapter.

This done, all the radiall lines of your Dyall issuing from ỹ Centre D. of the Equinoctiall circle T. E. V. to the touch line P. Q. viz. D. O. D. N. D. L. D. Y. set them now in the Equinoctiall line A. K. of your Trigon, from A. towards K. in all respects, as in the last chapter you did: for if this Equinoctiall Semy-dyametre D. E. of this Dyall had bene equall to the Equinoctiall Semy-dyametre A. O. of the last chapter, then had these diuisions bene all ons and the selfe same with the diuisions, A. O. A. 1. A. 2. A. 3. A. 4. and A. 5. of the last chapter. Hauing therefore set your notes A. D. A. O. A. N. A. L. A. Y. &c. in the line A. K. of the Trigon, you shall then from Q. draw slope radial lines by all those notes crosse ỹ whole Trigon, & set numbers to them on both sides of this Trigon in capitall letters to bee knowne from the former, viz. + XI. IX. VIII. VII. at the lines A. H. and H. I. And + I. II. III. IIII. V. VI. VII. & VIII. at the line A. I. These I may call the howerlines of the Trigon, & because in all Dyals the 6. of clocks line representeth the Equinoctial line, crossing alwaies the Meridian or twelue of clocke line square, therefore you shall on your Trigon draw the hower line Q. VI. VI. parrallell to the Equinoctiall line A. K. and then set Q. VII. V. as much from Q. VI. as Q. V. VII. is on the other side, and Q. IIII. as much as Q. IIII. VIII. is on the other side, and so is our Trigon prepared as well as your Dyall.

All that you haue now to doe, is but to plant all in the intersections of the Trigons radiall line with these his slope howerlines, according to their distances from Q. with notes made in their correspondent howerlines of the dyall, from the Dyals centre, as in the last chapter you did with the intersections of the same radiall lines with the parrallell howerlines of the Trigon, the one halfe of the intersections

next to Q. must lye in euery howerline of the Dyall from the Dyals Equinoctiall P.Q. towards the Centre C. of the Dyall, as in the Trigon they lye towardes the radiall Centre point Q. of the Trigon from his Equinoctiall A.K. The other halfe of the intersections must lye on the other side of the dyals Equinoctiall P.Q.

For example, I haue in this figure planted the intersections of the twelue of clocke howerline of the Trigon Q.+D.+ with the radiall lines of the Trigon beginning ♈. ♓. and Pisces, and ♈. ♓ and 69. in the twelue of clocke line of the Dyall, viz. those of Q.+D. of the Trigon in C.E. of the dyall by the notes B.C. and G. and those of D.+. in the Trigon beyond D. in the same twelue of clocke howerline of the Dyall beyond E. at the notes, F.H. and K. and in the very like manner shall you plant all the like intersections of all the howr lines of your Trigon on his match howerlines of your Dyall on each side of C.E, and make as many notes in the one howr line as in the other And last of all, by the match notes of euery houre line, you shall by hand draw all your parrallells each after other, as this picture sheweth: and if the halfe howerlines of your Dyall had beene drawne and also planted in your Trigon, so should your directions bee the truer when you come to drawe these parrallels on your Dyall as before.

The cocke to this Dyall must be a stile or wyer with a little button on the top of equall length to the Semydiametre of the Equinoctiall circle, viz. C.E. plum erected in the point E. where the twelue of clocke line, and the Dyals Equinoctiall line P.Q. doe crosse: Or you may haue a tryangle cocke as in the first booke 17. chapter making a notch in the point directly ouer E. that shall giue the shade to trace out these parrallels.

As for declining Dyals you must first draw the howers to the line of declination, and make him the Meridian or twelue of clocke, as in the 33. chapter was done in blinde lines,

lines, & set in the signes of them in all respects, as before you are taught, & when that is done then draw your deflecting or declining howers, as the 19. 20. 26. or 27. chapters doe teach, and so is that turne serued, but you must then put out the blinde howerlines by which the signes were put in.

As for the Polar Dyall, because no one of the parrallels of the Spheare doe crosse his plaine, therefore the Sunne can project none of them on the plaine, but all parrallell to the plaine quite beside it, either aboue it or below it.

Chap. 40.

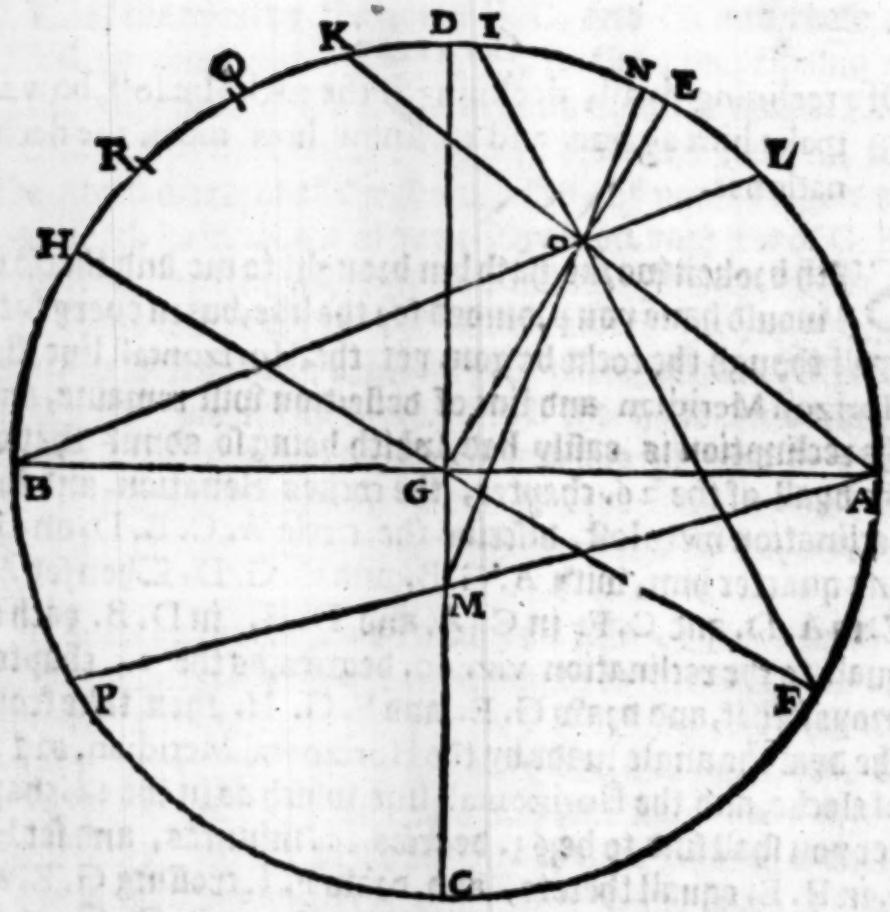
Of a reclining dyall, declining if the cocke be lost, how to make him againe, and to know how much the declination is.

Such broken worke hath bin brought to me, and therfore I would haue you prouided for the like, but in euery such dyall though the cocke be gon, yet the Horizontall line, the Horizon Meridian and line of deflection will remaine, and the reclination is easily had, which being so, admit that of the dyall of the 26. chapter, the cockes eleuation, and the declination were lost, discribe the circle A. C. B. D. on G. and quarter him, with A. G. B. and C. G. D. Then set A. E. in A. D. and C. F. in C. A. and D. H. in D. B. each equall to the reclination viz. 60. degrées, as the 24. chapter propoſeth it, and draw G. E. and F. G. H. then take from the dyal the angle made by the Horizontal Meridian, or 12. of clocke, and the Horizontall line, which as in the 26. chapter you shall find to be 63. degrées 30. minutes, and set H. I. in H. E. equall thereto, and draw F. I. crossing G. E. at O. then extend A. O. to cut B. E. at K. and B. O. to cut A. D. at L. then set B. R. in B. K. equall to A. L. then deuide R. K. in halfe at Q. I say D. Q. is the declination sought for, viz. 30. degrées, & that westwards, because the line of

declination lieth on the east side of the 12. of clocke line.

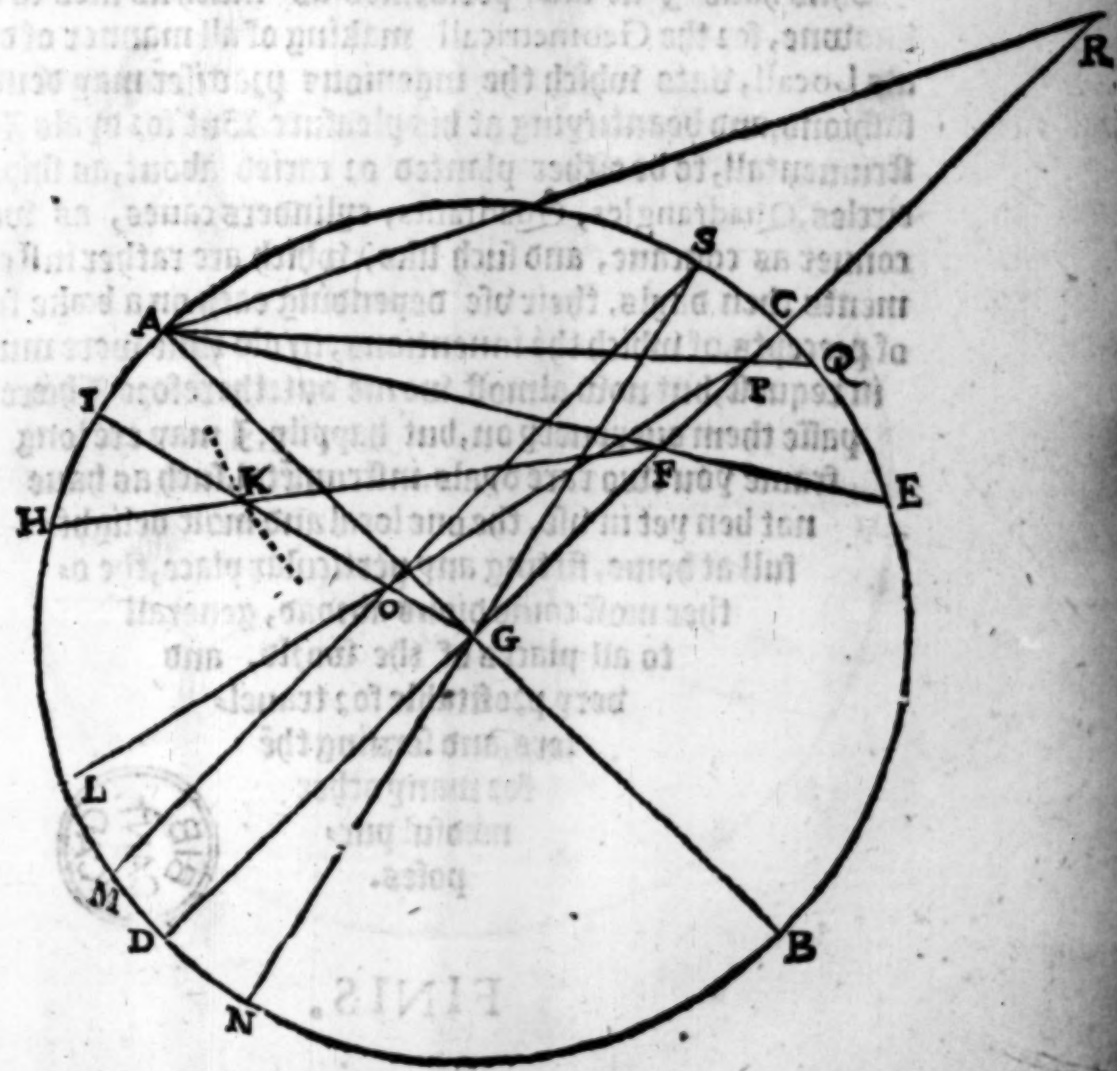
Then set B. P. in B. C. equall to D. Q. and draw A. P. cutting G. C. at M. lastly extend M. O. to cut D. E. at N. I say that D. N. is the mounting of the Horizontall Meridian, or 12. of clocke line viz. 26. degrees 30. minutes, as in the 24. and 25. chapters it was, which taken out of the latitude 51. degrees 40. minutes leaueth 24. degrees 10. minutes the position latitude.

These had, then describe againe your circle A. C. B. D.



quarter

quarter him and set C. E. in C, B. equall to the said mounting, viz. 26. degrees 30. minutes, and draw A. E. cutting G. C. at F. then set A. H. in A. D. equal to the declination, and draw F. H, then from A. extend A. R. cutting G. C. extended at R. and to make with A. E. an angle, equall to E. A B. then from R. with the width R. A. cut off F. H. at K. then extend G. K. to cut A. D. at I. I say that A I. is the position deuiation, viz. 15. degrees 50. minutes, but that we haue no need of, but you shall set C. S. in C. A. and D.



N. in D. B. equall to A. I. and draw S. G. N. then set N. M. in N. I. equall to the position latitude before gotten, viz. 24. degrees 10. minutes, and draw S. M. cutting G. I. at O. Then set C. Q. in C. B. equal to your angle of declination, viz. the angle included betweene the Horizontall Meridian and line of declination, which you shall finde on the dyall to be 6. degrees Then draw A. Q. cutting G. C. at P. lastly extend P. O. to cut D. A at L. I say that you shall finde D. L. 24. degrees 10. minutes which is the height of the cocke desired.

Thus haue I at last, performed as much as need to be knowne, for the Geometricall making of all manner of dyals Locall, vnto which the ingenious practiser may deuise fashions, and beautifying at his pleasure But for dyals Instrumentall, to be either planted or caried about, as ships, circles, Quadrangles, Quadrants, cylinders caues, as well conuex as concaue, and such like, which are rather instruments then dayls, their vse depending each on a booke full of precepts, of which the inuentions, in old time were much in request, but now almost worne out: therefore I here passe them ouer euery on, but happily, I may ere long frame you two rare dyals, instrumētal, such as haue not ben yet in vse, the one local and most delightfull at home, fitting any perticular place, the other most commodious abroad, generall to all places of the world, and very profitable for trauellers, and serning thē for many other needful purposes.

FINIS.